Windsor Bridge replacement project

Environmental assessment modification

Roads and Maritime Services | September 2019

NSW GOVERNMENT

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Roads and Maritime Services

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September 2019

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Approval and authorisation

Title	Windsor Bridge replacement project
Accepted on behalf of Roads and Maritime Services by:	Graham Standen Senior Project Manager
Signed:	
Dated:	24th September 2019

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1 Introduction

1.1 Purpose of this report

This report provides the environmental assessment for the proposed modification to the Windsor Bridge Replacement project (the project, WBRP) in accordance with section 5.25 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act). This report includes the following:

- An overview of the approved project;
- A description of the proposed modification
- An assessment of the potential impacts of the proposed modification
- Details of the changes to the conditions of the project approval potentially required by the proposed modification;
- Details of the changes to the approved environmental management measures required by the proposed modification; and
- Justification for the proposed modification.

The main elements for the proposed modification include the following.

- Inclusion of two through lanes at the northbound approach of the Bridge Street and George Street intersection; and
- A new merge lane exiting the Bridge Street and George Street intersection.

The proposed changes are described in Section 1.3.1 and in more detail in Chapter 4.

1.2 Windsor Bridge Replacement Project

Roads and Maritime Services (Roads and Maritime) is replacing the existing bridge over the Hawkesbury River at Windsor (known as 'Windsor Bridge') (refer Figure 1-1).

The project has been assessed as State Significant Infrastructure (SSI) under the former Part 5.1 of the EP&A Act.

The *Windsor Bridge Replacement Project Environmental Impact Statement* (EIS) (SKM, 2012) and the *Windsor Bridge Replacement Project Submissions Report* incorporating *Preferred Infrastructure Report* (SPIR) (SKM, 2013) were prepared for the Project. In December 2013, the Project was approved by the former Minister for Planning and Infrastructure (SSI-4951).

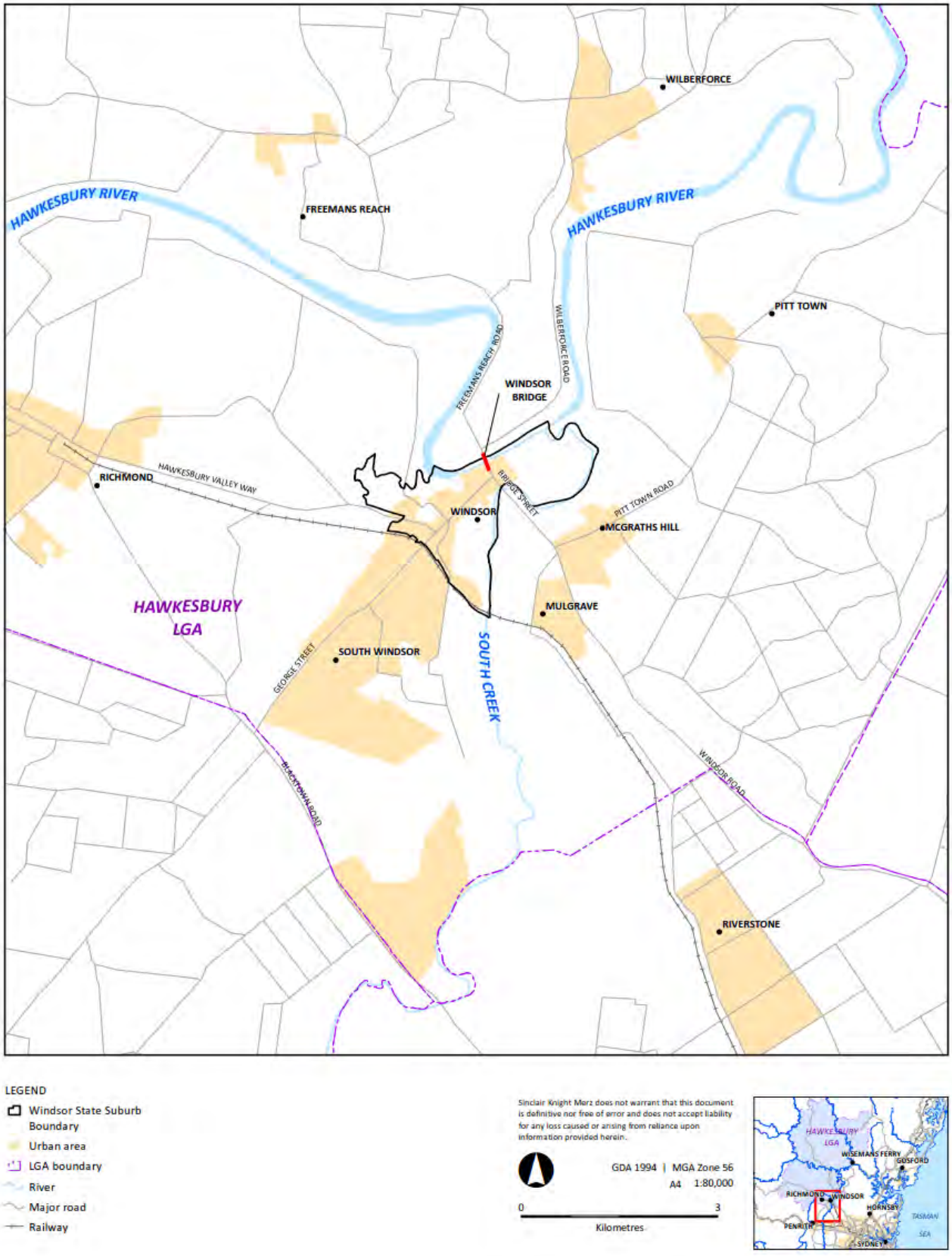


Figure 1-1 Location of the Windsor Bridge Replacement Project (Source: SKM, 2012)

The WBRP involves the following:

- Construction of a new bridge over the Hawkesbury River at Windsor, around 35 metres downstream of the existing Windsor bridge;
- Construction of new approach roads and intersections to connect the new bridge to existing road network;
- Modifications to local roads and access arrangements, including changes to the Macquarie Park access and connection of The Terrace;
- Construction of pedestrian and cycling facilities, including a shared pedestrian/cycle pathway for access to and across the new bridge;
- Removal and backfilling of the existing bridge approach roads;
- Demolition and removal of the of the existing road bridge, known as Windsor Bridge;
- Urban design and landscaping works, including within the parkland area of Thompson Square and adjacent to the northern intersection of Wilberforce Road, Freemans Reach Road and the Macquarie Park access road; and
- Ancillary works such as public utility adjustments, water management measures and scour protection works, as required.

Figure 1-2 provides an overview of the approved project.

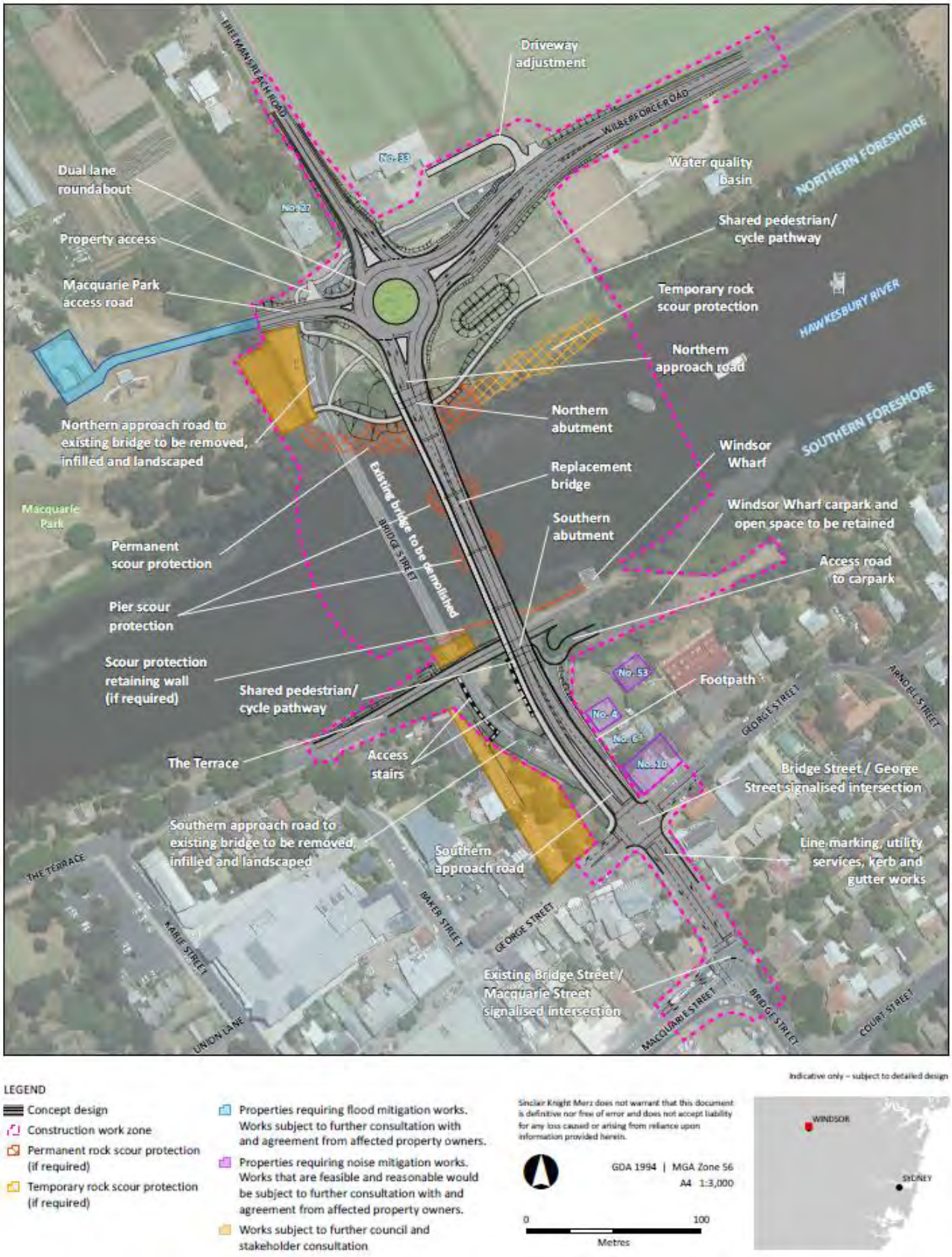


Figure 1-2: Key elements of the WBRP (Source: SKM, 2012)

1.3 The proposed modification

1.3.1 Description of modification

Roads and Maritime is proposing to include the following key components as part of this modification:

- Line marking changes to the two through lanes at the northbound approach of the Bridge Street and George Street intersection which includes the following:
  - left lane: shared left turn and through lane, and
  - right lane: dedicated through lane.
- A new merge lane exiting the Bridge Street and George Street intersection which includes the following:
  - 100 metres long (including a 30 metre parallel lane and 70 metre 'zip' merge lane), and
  - the lane merges into one northbound lane on the new bridge.

1.3.2 Need for this modification

Planning Approval was granted in December 2013, and in September 2018 a construction contractor was appointed to construct the approved project on behalf of Roads and Maritime.

Roads and Maritime has undertaken additional investigations to confirm traffic growth rates since the EIS was prepared. Essentially the new study indicated that traffic had grown slightly faster than originally predicted, and that about 2,000 additional vehicles per day could potentially be travelling the route in 2026 than predicted in 2012.

Consideration of this new information has led to this proposed design modification which would improve traffic flows in the long term and provide greater future proofing. There could be significant northbound delays in the afternoon peak at the Bridge Street and George Street intersection by 2026 if the design modification is not implemented.

1.4 Structure of this report

This report is structured as follows:

- Chapter 1 (Introduction) provides an overview of the modification, scope and purpose;
- Chapter 2 (Assessment process) outlines the statutory assessment requirements and explains the steps in the assessment and approval process;
- Chapter 3 (Approved project) provides a description of the approved project with a more detailed focus on the elements that are proposed to be changed by the proposed modification;
- Chapter 4 (Proposed modification) provides a detailed description of the proposed modification to the approved project including options considered;
- Chapter 5 (Consultation) outlines the consultation activities undertaken to date and in the future;
- Chapter 6 (Environmental assessment) identifies the relevant environmental issues, assesses the potential impacts of the modification and presents environmental management measures in response to those impacts;
- Chapter 7 (Conditions of approval) identifies the conditions of the project approval that are required to be amended as part of the proposed modification;

- Chapter 8 (Environmental management measures) details changes to the approved environmental management measures as a result of the proposed modification;
- Chapter 9 (Justification and conclusion) presents the justification the proposed modification and provides a summary of the key assessment findings;
- Appendix A (Design drawings);
- Appendix B (Traffic and options modelling report);
- Appendix C (Heritage assessment);
- Appendix D (Aboricultural impact assessment);
- Appendix E (Landscape character and visual impact assessment); and
- Appendix F (Nosie assessment).

2 Assessment process

2.1 Approval framework

2.1.1 Approved project context

Roads and Maritime formed the opinion that the project would likely significantly affect the environment and would require an EIS under the former Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

An application report to support a SSI application under Section 115X of the EP&A Act was prepared by Roads and Maritime. This application was submitted to the Department of Planning and Infrastructure on 4 October 2011 and the Director General's requirements (DGRs) for environmental impact statement were issued on 24 November 2011. In accordance with the requirements of the EP&A Act, an EIS was prepared to assess the potential impacts of the project.

The project EIS was publically displayed for 34 days between 14 November 2012 to 17 December 2012. The exhibition generated 101 submissions which were responded to in Submissions Report which also incorporated a Preferred Infrastructure Report (SKM, 2013).

The WBRP was approved on 20 December 2013 by the Minister for Planning and Infrastructure subject to the Minister's conditions of approval (MCoA). Any refinements to the project which are not consistent with the approved project must be approved by the Minister under Section 5.25 of the EP&A Act.

2.1.2 Proposed modification

Roads and Maritime seeks a modification of the Minister's approval under Section 5.25 of the EP&A Act.

This modification to the approved project has been prepared for the purposes of seeking approval for the new northbound merge lane as a modification to the WBRP.

Roads and Maritime seeks to modify Condition A1 of the MCoA to include reference to this report, to include the new merge lane as part of the project.

2.2 Environmental planning instruments

Section 2.1.2 of the EIS provides an overview of the environmental planning instruments (EPIs) relevant to the project. This section notes: *Environmental planning instruments do not apply to or in respect of State significant infrastructure, except where they apply to the declaration of infrastructure as State significant infrastructure (EP&A Act s.115ZF(2)*) (now section 5.22(2)). Nevertheless, a review of Section 2.1.2 of the EIS has been undertaken and the EPIs relevant to the project remains valid for this modification application and as such it has not been repeated below.

A review of current EPIs has identified that two new State Environmental Planning Policies (SEPPs) have been gazetted since lodgement of the EIS for the project. These are *State Environmental Planning Policy (Coastal Management) 2018* (Coastal SEPP) and *State Environmental Planning Policy (Vegetation in Non-Rural Areas) 2017* (Vegetation SEPP). A review of the mapping for the Coastal SEPP showed that the proposed modification would not involve works on land identified as 'coastal wetlands'. As such, requirements of the Coastal SEPP are

deemed not relevant for the proposed modification. As no additional areas of vegetation are proposed to be removed as a result of the proposed modification, the Vegetation SEPP is also deemed not relevant for the proposed modification.

2.3 Other NSW legislation

Other environmental legislation which may be relevant to the proposed modification has been reviewed. The review confirmed that there are no additional requirements above those identified in the EIS (SKM, 2012).

2.4 Commonwealth Environmental Protection and Biodiversity Conservation Act 1997

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) proposed 'actions' that have the potential to significantly impact on matters of national environmental significance, the environment of Commonwealth land or that are being carried out by a Commonwealth agency must be referred to the Commonwealth Government. If the Commonwealth Minister for Environment and Energy determines that a referred project is a 'controlled action' under the EPBC Act, the approval of that minister would be required for the project in addition to the NSW Minister for Planning and Infrastructure's approval.

Based on the results of the environmental investigations carried out for the EIS, it was determined that no matters of national environmental significance (NES) or areas of Commonwealth land are likely to be impacted by the project. Accordingly Roads and Maritime decided that no referral was required.

Based on the nature and extent of the proposed modification, no matters of NES are likely to be impacted and a referral is not required.

3 Approved project

3.1 The project

The project includes a replacement bridge 35 metres downstream from the existing bridge, modifications to the existing intersections, new bridge approach roads to accommodate the new bridge location, and provision of a shared pedestrian and cycle pathway for access to and across the replacement bridge.

Planning approval was granted by the former Minister for Planning and Infrastructure under the former Part 5.1 of the EP&A Act on 20 December 2013.

The key components of the approved project are outlined in Section 1.2 and the project is fully described in Chapter 5 of the EIS (SKM, 2012) and Chapter 5 of the Submissions Report incorporating Preferred Infrastructure Report (SPIR) (SKM, 2013).

There have been no previous modifications to the approved project.

3.1.1 Project objectives

The primary aim of the Project is to provide a safe and reliable crossing of the Hawkesbury River at Windsor. Specific objectives for the project, as outlined in the EIS are:

- To improve safety for motorists, pedestrians and cyclists;
- To improve traffic and transport efficiency;
- To improve the level of flood immunity;
- To meet long term community needs;
- To minimise the impact on heritage and the character of the local area; and
- To be a cost effective and an affordable outcome.

The proposed modification on balance is consistent with the above objectives, in particular the new north bound merge lane would improve safety for motorists, pedestrians and cyclists and would improve traffic and transport efficiency.

3.2 Bridge Street overview

The Bridge Street and George Street intersection component of the project would be changed as a result of the proposed modification. The approved project has one dedicated northbound through lane at the Bridge and George Street intersection and across the bridge, and one dedicated northbound left hand turn lane into George Street as shown on Figure 3-1.

Roads and Maritime is proposing to change the line marking to allow two through lanes (one dedicated, one shared left turn) and construct a new northbound merge lane after the Bridge Street and George Street intersection.

3.3 Construction program

Construction of the approved project commenced in September 2019 and these components of the project are anticipated to be complete by early 2021.

The EIS anticipated that a construction period of around 20 months would be required to complete the project, including demolition of the existing bridge.

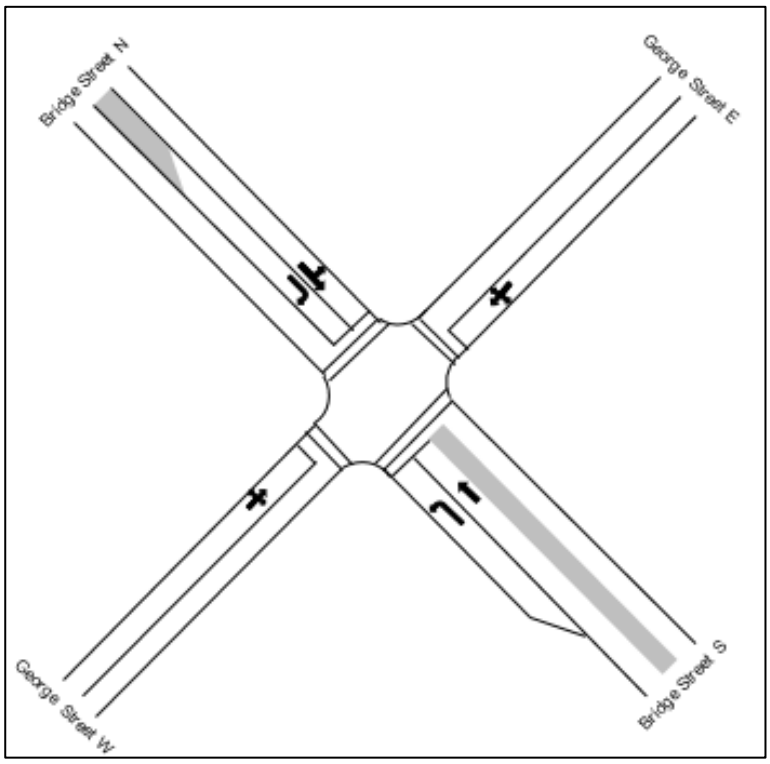


Figure 3-1: Approved layout of the Bridge Street and George Street intersection

3.4 Construction hours

The approved project is being undertaken as a mix of both standard and out of hours construction works. Condition C13 of the MCoA defines standard construction hours:

- 7:00am to 6:00pm Mondays to Fridays, inclusive; and
- 8:00am to 1:00pm Saturdays; and
- at no time on Sundays or public holidays.

Out of hours works are subject to the Out of Hours Work Protocol as required by Condition C14 and Condition D5(c) of the MCoA. The Construction Noise and Vibration Management Sub-Plan provides a process for seeking approval for out of hours works, including consultation and identification of mitigation measures for residual impacts.

3.5 Construction road network

A Construction Traffic Management Sub Plan has been prepared to manage the disruptions to traffic movements as a result of construction traffic associated with the approved project, in accordance with Condition D5(a) of the MCoA. The sub-plan was approved by the former Department of Planning and Environment (DP&E) on 15 March 2019 and is currently implemented.

4 Proposed modification

4.1 Project design development

Roads and Maritime is seeking to modify the existing project approval for the construction and operation of the project. An overview of the approved project is provided in Chapter 3 of this report.

The EIS assessed indicative concept designs, which were subject to the detailed design process. Approval for the project was granted by the former NSW Minister for Planning and Infrastructure on the 20 December 2013 (application number SSI-4951). More than five years after the planning approval was granted, a contractor was appointed to construct the project on behalf of the proponent, Roads and Maritime. The project is currently under construction.

The contractor or the proponent may offer an alternate design or construction methodology that has a beneficial project outcome in consideration of environmental and social impacts. Where this occurs, a post-approval process under the EP&A Act (refer Chapter 2) is undertaken.

These processes may include a consistency assessment where proposed changes are deemed consistent against the current Planning Approval. Or where the proposed changes are not considered to be consistent, a modification to the planning approval under section 5.25 of the EP&A Act is sought.

4.2 Design options considered

Options were considered by Roads and Maritime when developing the proposed modification, including the do nothing option. As part of the options analysis, each option was reviewed against the project objectives.

The approved project has one dedicated northbound through lane at the Bridge and George Street intersection and across the bridge, and one dedicated northbound left hand turn lane into George Street. The new traffic study shows that during the afternoon peak there will likely be more congestion and delays at the Bridge and George Street intersection than originally anticipated unless there is a better opportunity for vehicles to merge prior to approaching the new bridge. This opportunity can be realised by either incorporating an additional lane on the bridge or by allowing two lanes of northbound traffic to move through the intersection and merge prior to reaching the bridge.

The option of adding an additional north-bound lane on the new bridge was considered but deemed to be unacceptable and unnecessary for the following reasons:

- Significant cost associated with widening the bridge deck;
- A longer period of disruption to the community and traffic for the construction;
- Greater impact on heritage and character of the local area; and
- A further reduction of the Thompson Square parkland associated with changes required to the bridge approach and foundations.

The proposed option of the merge lane best meets the project objectives of minimising the impact on heritage and the character of the local area, meeting the long term community needs and providing a cost effective and affordable outcome.

The option of constructing a new merge lane and the do nothing option are considered in further detail below.

Option 1 is the do nothing option and involves not undertaking the modification and retaining the current intersection design as shown in Figure 4-1.

Figure 4-1: Option 1 – Do nothing option

Option 2 involves modifying the line marking to include two northbound through lanes at the approach of the Bridge Street and George Street intersection, and widening the northbound lane to include a new merge lane exiting the Bridge Street and George Street intersection (refer Figure 4-2).

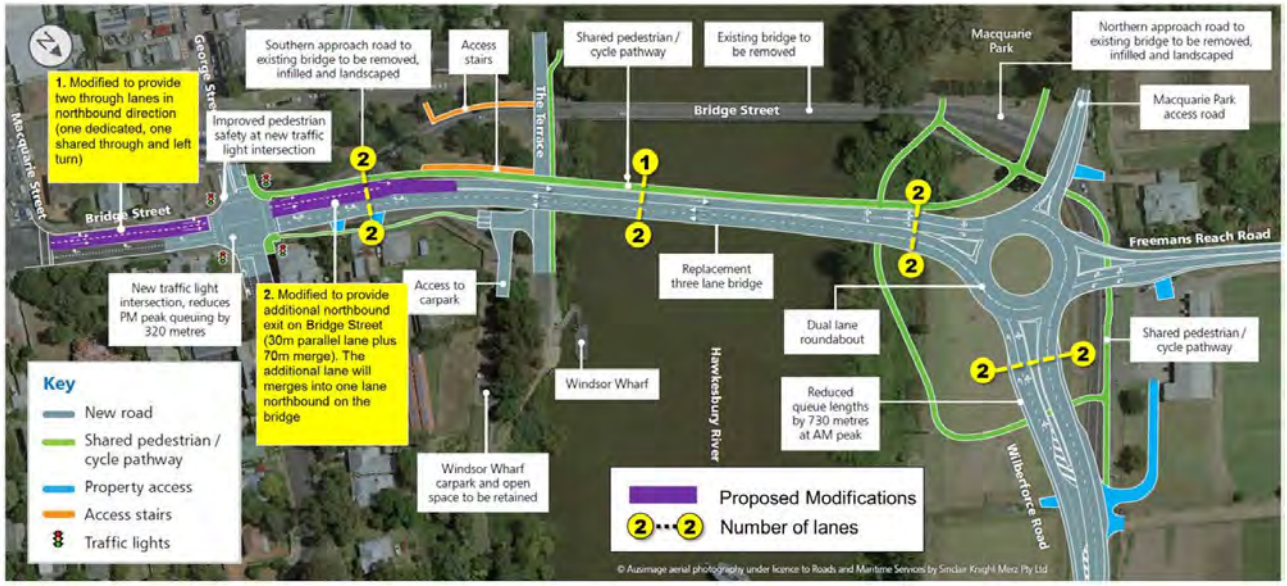


Figure 4-2: Option 2 – Preferred option

Analysis of the two options is provided in Table 4-1 .

Table 4-1: Advantages and disadvantages of the two options

Option	Advantages	Disadvantages
Option 1 Do nothing	No encroachment of the Thompson Square parkland. No potential for additional impacts on historical and aboriginal heritage. Landscape character impact and visual impacts would remain unchanged from those assessed in the EIS. No change in amenity of the recreational receivers of the Thompson Square parkland. Overall project cost could remain unchanged.	Greater unacceptable traffic and pedestrian delays within five years after opening and into the future at the Bridge Street and George Street intersection. The future Level of Service (LoS) analysis (Arcadis, 2018) found that if no action is taken to amend the approved design, the following is likely to occur: • Major congestion at a number of key intersections during peak periods by 2026 extending throughout a large part of the day; • Of the three key intersections analysed, two intersections showed LoS E in the afternoon peak in 2026 and two intersections showed a LoS F (over capacity) in the afternoon peak in 2036. The LoS categories are listed in Table 6-2; • Significant delaying and queuing would occur on Bridge Street in the afternoon peak; and • Road safety would potentially deteriorate on Bridge Street and associated intersections for all road users as traffic increases. The traffic delays outlined in the new traffic report (Arcadis, 2018) would not be addressed by the do nothing option even though the issues have been recognised. To defer the work to a later time would be more costly and prolong impacts to the community, such as traffic delays and amenity impacts, than undertaking the works concurrently with the approved project. The project objectives, outlined in the EIS, of improving safety for motorists, improving traffic and transport efficiency and meeting the long term community needs would not be met.
Option 2 New north bound merge lane	Improve traffic flow and reduce travel times by allowing two lanes of northbound traffic to move through the intersection, rather than one. This would allow additional time for vehicles to merge prior to reaching the bridge.	Encroachment of an additional 160 square metres of the Thompson Square parkland. Slight increase in the magnitude of the landscape character impact and visual impact from two viewpoints.

Option	Advantages	Disadvantages
	Small impact on the overall construction cost and minimal additional community disruptions, if undertaken concurrently with building the approved project. Generally consistent with the objectives outlined in the EIS, in particular the proposed modification would improve safety for motorists, pedestrians and cyclists, would improve traffic and transport efficiency, and would meet the long term community needs.	Slight reduction in amenity of the recreational users of the Thompson Square parkland. The achievement of the project objective to minimise the impact on heritage and the character of the local area would be less than the do nothing option.

Based on the above, Option 2 was selected as the preferred option and would represent an overall beneficial outcome for the approved project. The proposed changes would, whilst resulting in some impacts, result in the benefits listed above which would provide an improved outcome in comparison to the approved project for the local community.

The primary aim of the project is to provide a safe and reliable crossing of the Hawkesbury River at Windsor. Option 2 is generally consistent with the objectives outlined in the EIS, in particular the proposed modification would improve safety for motorists, pedestrians and cyclists, would improve traffic and transport efficiency, and would meet the long term community needs.

4.3 Details of the proposed modification

Roads and Maritime is seeking to modify the existing project approval for the construction and operation of the project. Roads and Maritime is proposing to include the following key components as part of the proposed modification (refer Figure 4-3):

- Amendment 1: Line marking changes to the two through lanes at the northbound approach of the Bridge Street and George Street intersection which includes the following:
  - left lane: shared left turn and through lane, and
  - right lane: dedicated through lane.
- Amendment 2: A new merge lane exiting the Bridge Street and George Street intersection which includes the following:
  - 100 metres long (including a 30 metre parallel lane and 70 metre ‘zip’ merge lane), and
  - the lane merges into one northbound lane on the new bridge.

Figure 4-3: Proposed modification to the project

The proposed modification is contained within the construction work zone (project boundary) identified in the EIS as shown in Figure 4-4. However it is noted that the proposed modification would increase the physical footprint of the works and would encroach into the Thompson Square parkland. This encroachment is a narrow and tapered strip of land being some three metres at its widest point and a total area of around 160 square metres. The shared pedestrian/cycle path and access stairs, part of the approved project, would be shifted west by up to approximately three metres.

4.3.1 Amendment 1

Amendment 1 would include line marking changes on Bridge Street at the northbound approach to the Bridge Street and George Street intersection to provide two through lanes in the northbound direction (one dedicated and one shared through and left turn).

No additional land is required to support this amendment.

4.3.2 Amendment 2

Amendment 2 includes a new merge lane exiting the Bridge Street and George Street intersection for traffic travelling north toward the new bridge. The new merge lane would require a narrow and tapering strip of land in the south-east corner of Thompson Square. This strip of land would measure between zero and 3 metres in width over a length of 100 metres. The proposed amendment would involve taking approximately 160 square metres from Thompson Square.

At the upper and southern end of the proposed merge lane, the widening comprises an existing area of grass and bare earth on the road verge. At the lower and northern end of the merge lane the area would be comprised of fill placed above the surface of the existing Bridge Street (refer Figure 4-4).

Design drawings are located in Appendix A.

4.4 Construction

The construction of the work covered by the modification if approved would commence in mid 2020. The methods, activities and equipment used to construct the new northbound merge lane would be consistent with those used to construct the new bridge approach. The approved site compound on the northern side of the river would be used to support construction of the proposed modification.

The modification would be undertaken as a mix of both standard and out of hours construction works in accordance with the MCoA. Condition C13 defines standard construction hours:

- 7:00am to 6:00pm Mondays to Fridays, inclusive; and
- 8:00am to 1:00pm Saturdays; and
- at no time on Sundays or public holidays.

Daytime works for this modification would be undertaken during these hours. Where out of hours works is required, works would be subject to the Out of Hours Work Protocol as required by Condition C14 and Condition D5(c) of the MCoA. The Construction Noise and Vibration Management Sub-Plan provides a process for seeking approval for out of hours works, including consultation and identification of mitigation measures for residual impacts.

4.5 Operation

Operation of the proposed modification would include the ongoing use and maintenance of the new merge lane. This would include required pavement upgrades undertaken in line with Roads and Maritime road maintenance policies.

4.6 Conditions of Approval

The proposed modification would require one of the MCoA to be amended to ensure that the MCoA are consistent with the proposed modification. Chapter 7 details the changes that are proposed.

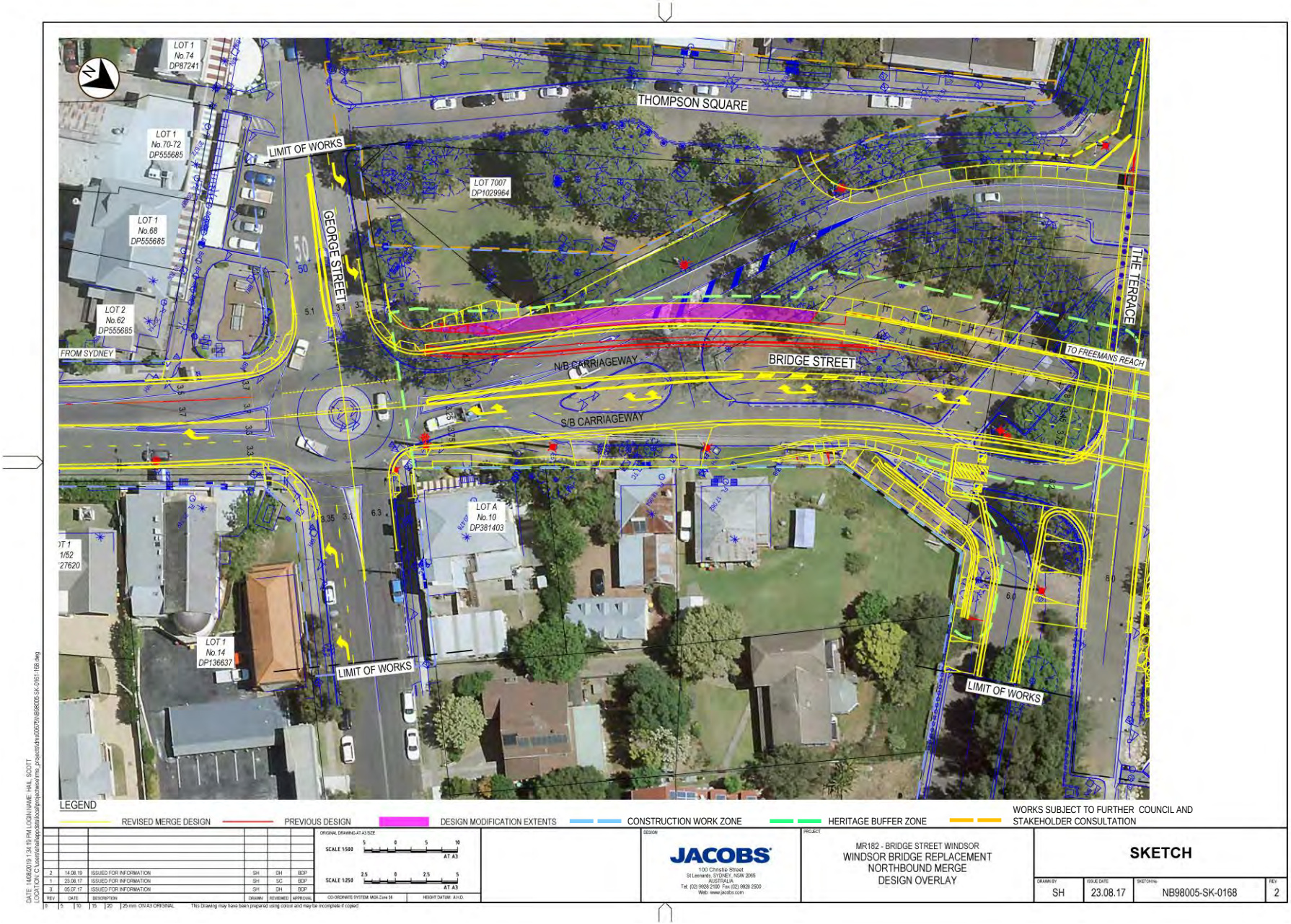


Figure 4-4: Design overlay of approved design and proposed modification

5 Consultation

5.1 Project communication and engagement tools

The communication and consultation approach has been guided by the Roads and Maritime *Community Engagement and Communications Manual,* which is informed by the International Association for Public Participation (IAP2) spectrum for public participation.

5.1.1 Community communication strategy

A community communication strategy (CSS) (Roads and Maritime, 2018a) was developed to support the construction of the WBRP and meet the requirements under Condition D13 of the MCoA. The strategy is a working document used by the project team to plan, implement and manage communication and engagement activities to support project milestones and construction activities.

The strategy outlines the communication and engagement objectives of the project. It also presents the communication approach, tools, key messages, protocols and evaluation to support the implementation of communication and engagement activities for this project.

The communication and engagement objectives for the project are to:

- Provide regular and targeted information to the community and stakeholders on the delivery of the project, including the likely impacts;
- Provide clear direction about whether we are providing information or seeking feedback so that expectations are clear;
- Ensure community and stakeholder feedback is continuously fed into communication and engagement;
- Ensure that issues are identified early and managed effectively;
- Manage feedback and complaints in a timely, respectful way;
- Collaborate with government agencies and local council to ensure a whole-of-government approach to managing issues and providing consistent messages;
- Monitor and evaluate stakeholder feedback and communication activities to measure success and review planning and delivery as required;
- Be transparent in all that we do;
- Listen to feedback, investigate suggestions, acknowledge lessons learned, and report back; and
- Engage in a manner that is collaborative, innovative, adaptive and sustainable.

5.1.2 Engagement tools

The communication approach for this project includes a number of tools and activities to keep the community and stakeholders informed, including, but not limited to:

- Community information phone number and email address;
- Project website;
- Postal address;
- Media releases, advertisements and traffic alerts;
- Notification letters, community updates and printed material;
- Face to face meetings; and
- Community events.

5.2 Project consultation

Roads and Maritime has carried out extensive consultation with the community and other stakeholders since the project was announced in 2008. Activities undertaken prior to project approval are detailed in Chapter 6 of the EIS (SKM, 2012) and the SPIR (SKM, 2013).

A number of different methods have been used to keep the community and other stakeholders informed of project progress and to invite feedback. A summary of consultation activities post project approval include:

- March – April 2017: Draft Urban Design and Landscape Plan (UDLP) displayed for community consultation. The UDLP was prepared in consultation with the former Office of Environment and Heritage (OEH) and Hawkesbury City Council;
- September 2017 – UDLP Submissions Report published outlining and addressing community and stakeholder comments;
- May 2017 – Community consultation on the draft Strategic Conservation Management Plan (SCMP). This document was prepared in consultation with the former OEH and in accordance with the relevant guidelines of the NSW Heritage Council;
- November 2017 – SCMP Submissions Report (Vol 4) published outlining community and stakeholder comments;
- September 2017 to March 2018: Engagement for the Heritage Interpretation of the Brick Barrel Drain. Consultation with the community included a community update in March which invited comments on the heritage interpretation, and direct email distributions. Engagement was also undertaken with the former DP&E, the former OEH and Hawkesbury City Council to prepare the heritage interpretation;
- May 2018 to August 2018 – Consultation with relevant stakeholders including the Environment Protection Authority (EPA), Department of Primary Industries (DPI) (Fisheries), former OEH, Natural Resources Access Regulator (NRAR), Hawkesbury City Council and the Aboriginal Focus Group (AFG) during preparation of the Construction Environmental Management Plan (CEMP) documentation;
- 2019 – Consultation with the community and stakeholders on the Interpretation plan; and
- Throughout the project – Provision of community updates and project notifications.

5.3 Consultation for the proposed modification

5.3.1 Updated traffic report

The Roads and Maritime engaged an independent traffic count and modelling report (Arcadis, 2018) for the project as just over five years had passed since the last traffic assessment was completed for the EIS (SKM, 2012). The report has led to the design change proposed as part of this modification, which would help to manage traffic in the long term.

The updated *Traffic and Options modelling report* (Arcadis, 2018) was placed on the Roads and Maritime project specific website in early 2018. No comments or feedback have been received on this report.

5.3.2 Community and Agency Stakeholders

Representatives of the Roads and Maritime met with representatives of the Department of Planning, Industry and Environment (DPI&E) - Planning and Assessment (formerly DP&E). During this meeting Roads and Maritime representatives provided information on the proposed modification and discussed the process for further consultation.

5.4 Future consultation for the proposed modification

5.4.1 Public display of modification

This modification will be placed on public display by the DPIE to enable the community and other stakeholders to provide comment on the proposal.

A community update will be issued to 10,000 residents and stakeholders explaining the modification and providing information on its public exhibition and how people can make submissions. The community update will be published on the Roads and Maritime project webpage.

Also meetings are planned with Hawkesbury City Council and the local Member of Parliament..

All submissions from public display of this modification report would be formally considered and responses would be provided in a submissions report, which would also be made available to the public.

5.4.2 Future consultation

Going forward, Roads and Maritime and the construction contractor would be required to inform the relevant stakeholders and the local community before and while the proposed modification is being constructed. This process would be managed through the Construction Environmental Management Plan (CEMP) and associated sub-plans, and the Community Consultation Strategy (CSS) outlined in Section 5.1.

6 Environmental assessment

6.1 Introduction

This chapter provides an environmental assessment of the proposed modification of the project. The assessment identifies potential impacts resulting from the proposed modification and provides a comparison with the impacts assessed in the EIS and the SPIR for the approved project.

6.2 Environmental Scoping

A scoping assessment has been completed to identify the likely potential environmental impacts associated with the proposed modification. This included an assessment of the potential changes to the environmental impacts described and discussed in the approved project planning approval documents (including the EIS and SPIR). Potential environmental impacts associated with the proposed modification that require assessment are identified in Table 6-1.

Table 6-1: Overview of potential change to environmental impacts

Environmental aspect	EIS	Applicable to proposed modification	
		Consideration of potential relative environmental impact	Where addressed
Traffic and Transport	• Section 7.3 • Working Paper 4 Traffic and Transport.	The proposed modification would improve the long term operational performance of project.	Section 0
Historic and maritime heritage	• Section 7.1 • Working Paper 1 Historic Heritage Assessment and Statement of Heritage Impact • Working Paper 2 Maritime Archaeological Statement of Heritage Impact	The location of the proposed modification is within an area suspected to contain historical archaeological deposits and relics which may be impacted.	Section 6.4
Aboriginal heritage	• Section 7.2 • Working Paper 3 Aboriginal Cultural Heritage Assessment Report.	The proposed modification would bring construction works closer to an area of highly significant Aboriginal archaeology sensitivity which may be impacted.	Section 6.5
Planted Trees	• Section 7.4 and 7.9 • Working Paper 10 Flora and Fauna. • Working Paper 5 Urban design and landscape.	The proposed modification would bring works closer to the trees within Thompson Square.	Section 6.6

Environmental	EIS	Applicable to proposed modification	
Visual amenity, urban design and landscape	• Section 7.4 • Working Paper 5 Urban Design and Landscape Concept Report.	The proposed modification would increase the width of Bridge Street by approximately three metres compared to the approved project. This has potential to increase the landscape character impact to Thompson Square and to increase visual impacts from some viewpoints. The modification would reduce the parkland area of Thompson Square along the Bridge Street frontage.	Section 6.7
Noise and vibration	• Section 7.5 • Working Paper 6 Noise and Vibration.	The proposed modification may change the predicted noise levels for residential receivers and recreational users of Thompson Square.	Section 6.8
Land use, property and socio-economic	• Section 7.8 • Working Paper 9 Land use, property and socio-economic.	The proposed modification would bring construction works and operational traffic slightly closer to the recreational users of Thompson Square potentially leading to reduced amenity. There would be a permanent partial loss of Thompson Square parkland.	Section 6.9
Soil, sediments, water and waste	• Section 7.6 • Working Paper 7 Soil, Sediments, Water and Waste.	The project is unlikely to have additional impacts than those identified in the EIS.	Section 6.10
Hydrology	• Section 7.7 • Working Paper 8 Hydrology	The project is unlikely to have additional impacts than those identified in the EIS.	Section 6.11
Air quality	• Section 7.10 • Working Paper 11 Air Quality.	The project is unlikely to have additional impacts than those identified in the EIS.	Section 6.12

6.3 Traffic and transport

6.3.1 Introduction

Traffic and transport impacts were discussed in Section 7.3 of the EIS and in *Working Paper 4 Traffic and Transport.* The revised *WBRP Construction Traffic Management Sub Plan* (Appendix B1 of the CEMP) was approved by DP&E 15 March 2019 and is currently implemented.

As over five years has passed since the last traffic assessment was completed for the EIS (SKM, 2012), Roads and Maritime undertook a new, independent traffic count and modelling report for the project. This Traffic and Options Modelling Report was prepared by Arcadis (2018) and is provided in Appendix B. A summary of the report is provided in the following sections.

The report documents existing 2017 traffic conditions and future traffic growth in the vicinity of Windsor Bridge, and provides an assessment of performance of the approved design and the proposed modification design from a traffic perspective. The report was prepared to assess the network performance of the approved design and identify possible cost-effective improvements.

A new traffic survey was undertaken in March 2017 to satisfy the need and purpose of the study. It included:

- Daily automatic traffic counts on Windsor Bridge;
- Intersection turning movement counts and queue length surveys. The survey was conducted for the following four intersections (refer Figure 6-1);
  - Wilberforce Road / Freemans Reach Road,
  - Bridge Street / George Street;
  - Bridge Street / Macquarie Street, and
  - Bridge Street / Court Street.
- Travel time surveys and speed surveys for one bi-directional route: Bridge Street/Wilberforce Road (between 500 metres south of Court Street / Bridge Street intersection and 500 m east of Freemans Road / Wilberforce Road intersection).

A road-based traffic model was developed for the project area using SIDRA Network software. The key objectives of the traffic modelling assessment was to determine the Level of Service (LoS) of the proposed upgrades taking into account expected traffic growth for 2026 and 2036. The LoS criteria for intersections are shown in Table 6-2.

A further traffic assessment was undertaken by Arcadis in August 2019. This assessment has confirmed and is consistent with the traffic data that was surveyed in March 2017.

Figure 6-1: Key intersections adjacent to Windsor Bridge (Source: Arcadis, 2018)

6.3.2 Existing environment

6.3.2.1 Key Roads

Bridge Street is a sub-arterial road running in a north-west and south-east direction within the study area. It links Windsor Road (A2) and Wilberforce Road from Mulgrave to Windsor. It integrates the existing Windsor Bridge and forms part of the A2. Key intersecting roads include Court Street, Macquarie Street, George Street and Freemans Reach Road as shown in Figure 6-1. It is primarily one lane in each direction, with additional turning lanes provided at the intersection with Macquarie Street and Court Street. The posted speed limit is 60 km/h and the road bends sharply at both ends of the bridge.

Truck and bus travel speeds are limited to 40 km/h on the bridge. Bridge Street is part of the B-double route from Windsor Road to Wilberforce Road.

Wilberforce Road is a sub-arterial road running north-east and south-west from Bridge Street, connecting Windsor to Wilberforce and forming part of State Route 69 to Singleton. The road is

one lane in each direction with a posted speed limit of 80 km/h in the section approaching Windsor Bridge. Wilberforce Road is part of a B-double route running from Windsor Road via Bridge Street.

Key intersections in the project area include (refer Figure 6-1):

- Wilberforce Road / Freemans Reach Road (I-I);
- Bridge Street / George Street (I-2);
- Bridge Street / Macquarie Street (I-3); and
- Bridge Street / Court Street (I-4).

6.3.2.2 Public transport

The project area is serviced by public transport routes operated by Busways. The project area has no direct rail service. The nearest railway station by road is Windsor Station, approximately two kilometres from Bridge Street via Macquarie Street and George Street.

6.3.2.3 Crash history

Crash analysis was undertaken for Bridge Street and Wilberforce Road between Freemans Reach Road and Macquarie Street for a five year period between July 2011 and December 2016.

There were 52 crashes recorded during this period on Bridge Street and Wilberforce Road between Freemans Reach Road and Macquarie Street. Of all crashes reported, 41 crashes occurred at intersections, eight crashes occurred on the undivided road sections, and three crashes occurred on the divided road sections.

6.3.2.4 Walking and cycling

There are dedicated footpaths along Bridge Street, Macquarie Street, George Street and Court Street. Windsor Bridge has a narrow pedestrian and cycle path on its eastern side. This shared path links The Terrace and Old Bridge Street in the south with the intersection of Wilberforce Road and Freemans Reach Road to the north. The shared path on the existing bridge also forms an off-road link in the local cycle network.

Pedestrian access and amenity at the Bridge Street / George Street roundabout is currently poor. Pedestrian access is typically poor at roundabout controlled intersections and is made worse in this case by the fact that the intersection is located at the top of a crest. The existing intersection presents a road safety hazard for pedestrians and cyclists due to the high peak traffic volumes and poor sight distance at the intersection. No facilities are provided at the current roundabout controlled intersection to assist crossing Bridge Street, and pedestrians have difficulty identifying a safe gap in which to cross during peak traffic periods. As well as being a considerable safety risk to pedestrians crossing at this point, it provides a barrier to pedestrian movements from the eastern section of the town, where much of the accommodation is located, to the town centre.

An on-road cycle way is currently provided on Bridge Street and Wilberforce Road. A designated off-road cycle way exists on Bridge Street, Wilberforce Road and Macquarie Street.

6.3.2.5 Daily traffic volume

The following points are noted in relation to daily traffic volumes on Windsor Bridge:

- Currently (2017), Windsor Bridge (Bridge Street over Hawkesbury River) carries between 21,000 and 22,300 vehicles per day on a weekday (Monday to Friday) with an average of 21,600 vehicles per day;
- Based on averaged weekday (5 days), Windsor Bridge carries about 2,400 heavy vehicles per day representing about 11 per cent of total volumes; and

- Weekend (Saturday and Sunday) traffic is significantly lower than weekday traffic, being about 22 per cent lower than weekday average (5 days).

6.3.2.6 Peak hour and travel direction

The following points are noted in relation to peak hour traffic on the Windsor Bridge (Bridge Street over Hawkesbury River):

- The morning peak spreads over three hours between 6 am and 9 am, with traffic building up sharply between 7 am and 8 am when it reaches its peak;
- The afternoon peak also spreads over three hours between 3 pm and 6 pm, with traffic volumes gradually starting to build up around 3 pm. The peak is reached at 5 pm before it starts to decline sharply; and
- In the morning peak hour traffic direction is southbound towards Rouse Hill/Parramatta. This is mirrored in the afternoon peak with a similar volume of traffic heading northbound towards Wilberforce. The current peak hour directional traffic distribution on Windsor Bridge suggests typical 'tidal flow' distribution.

6.3.2.7 Capacity assessment of Windsor Bridge

The capacity analysis suggests that current traffic on Windsor Bridge exceeds the saturation traffic levels in both the morning and afternoon peak periods.

6.3.2.8 Intersection performance

Four intersections within the project area were analysed to determine the operating performance and Level of Service (LoS) including:

- Wilberforce Road / Freemans Reach Road (sign controlled);
- Bridge Street / George Street (roundabout);
- Bridge Street / Macquarie Street (traffic signals); and
- Bridge Street / Court Street (sign controlled).

The intersection performance analysis uses LoS as the measure of intersection performance. The LoS criteria for intersections is shown in Table 6-2. LoS is a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers.

Table 6-2: LoS criteria for intersections

LoS	Average delay per vehicle (ser/veh)	Traffic signals and roundabout	Give way and stop signs
A	Less than 15	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents will cause delays Roundabouts require other control mode	At capacity, requires other control mode

LoS	Average delay per vehicle (ser/veh)	Traffic signals and roundabout	Give way and stop signs
F	Over 70	Extra capacity required	Extreme delay, traffic signal or other major treatment required.

The existing 2017 LoS at the four analysed intersections is shown in Table 6-3.

Table 6-3: Existing intersection operation, 2017 base

Intersection	Control	AM Peak		PM Peak	
		Delay (sec)	LoS	Delay (sec)	LoS
Wilberforce Road /Freemans Reach Road	Priority	59	E	60	E
Bridge Street/George Street	Roundabout	41	C	97	F
Bridge Street/Macquarie Street	Signals	15	B	29	C
Bridge Street/Court Street	Priority	37	C	22	B

The following points are noted for existing network performance:

- Two intersections north and south of Windsor Bridge currently operate at or over their capacity during peak hour. Wilberforce Road / Freemans Reach Road (sign controlled intersection) currently operates with LoS E in the morning and afternoon peaks (delays of 60 seconds). Bridge Street / George Street (roundabout) currently operates at LoS F in afternoon peak (delays of 97 seconds). The operational issues at both intersections adversely impact the traffic performance on Windsor Bridge during peak hours; and
- The Bridge Street / Macquarie Street traffic signals operate with LoS between B to C (delays of 15 to 29 seconds) and Bridge Street / Court Street (sign controlled) intersection operates with LoS between B to C (delays of 22 to 37 seconds).

6.3.2.9 Historical Traffic Growth

The historical traffic growth on Windsor Bridge was estimated using 2012 and 2017 counts. The data shows that between 2012 and 2017 (5 years) traffic on Windsor Bridge has grown by approximately 1.1 percent per annum from 19,100 vehicles per day in 2012 to 20,000 vehicles per day in 2017 (average weekly – 7 day).

6.3.3 Impact assessment

6.3.3.1 Future traffic volumes

Future traffic growth on Windsor Bridge, Bridge Street and adjoining roads within the project area will be influenced by the combination of passing (through) and local traffic growth. Future traffic growth in the project area was sourced from Roads and Maritime's Strategic Traffic Forecasting Model (STFM, EMME model). Roads and Maritime provided traffic forecasts at key roads for each time period up to 2026 and 2036. Both morning and afternoon peak hour traffic was assessed in the future years. Table 6-4 shows future traffic growth rates proposed for traffic modelling for the project.

Table 6-4: Proposed growth rates for traffic modelling purposes

Road	2016-2026 (%)	2026-2036 (%)	2016-2036 (%) (average for 20year period)
Morning Peak			
Bridge Street, (Windsor Bridge) and Macquarie Street	1.7	1.0	1.3
George Street and Court Street	0.5	0.5	0.5
Afternoon Peak			
Bridge Street, (Windsor Bridge) and Macquarie Street	1.7	1.1	1.4
George Street and Court Street	0.3	0.3	0.3

Table 6-4 indicates the following:

- The future traffic growth rate on Bridge Street (Windsor Bridge) and Macquarie Street will be 1.7 per cent per annum between 2016 and 2026, followed by 1.1 per cent per annum between 2026 and 2036; and
- On George Street and Court Street, a lower traffic growth rate was suggested. Traffic volumes on George Street and Court Street would grow by between 0.3 per cent and 0.5 per cent between 2016 and 2036.

Future traffic volumes on new Windsor Bridge were prepared for the future years 2026 and 2036.Table 6-5 shows forecast average weekday daily traffic on new Windsor Bridge for 2026 and 2036.

Table 6-5: Estimated average weekday traffic on Windsor Bridge for 2026 and 2036

	Existing			Forecast Average Weekday Traffic (vehicles)					
	2017			2026			2036		
	NB	SB	Two-way	NB	SB	Two-way	NB	SB	Two-way
Daily	10,800	10,800	21,600	12,500	12,500	25,000	14,000	14,000	28,000
AM Peak	430	1,050	1,480	500	1,230	1,730	550	1,360	1,910
PM Peak	1,220	570	1,790	1,420	660	2,080	1,590	730	2,320

In 2026, traffic on new Windsor Bridge is projected to be about 25,000 vehicles per day. By 2036, traffic is forecast to grow to about 28,000 vehicles per day.

In the morning, southbound peak traffic on the new bridge is predicted to be about 1,200 vehicles per hour in 2026 and 1,400 vehicles per hour in 2036. Similarly, in the afternoon, northbound peak

traffic on the new bridge is predicted to be about 1,400 vehicles per hour in 2026 and 1,600 vehicles per hour in 2036.

6.3.3.2 Intersections

The traffic performance of the proposed modification design (including new northbound merge lane) was assessed for year 2026 and 2036 traffic conditions. Table 6-6 summarises the forecast 2026 and 2036 LoS results for the proposed modification design for the morning and afternoon peak hours.

Table 6-6: Forecast LoS in 2026 and 2036 for the approved and proposed modification design

Intersection	Control	Approved design				Proposed modification design			
		AM Peak		PM Peak		AM Peak		PM Peak	
		Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
2026									
Wilberforce Road/Freemans Reach Road	Roundabout	15	B	17	B	15	B	17	B
Bridge Street/George Street	Traffic signals	17	B	62	E	16	B	20	B
Bridge Street/Macquarie Street	Traffic signals	21	B	56	E	20	B	48	D
2036									
Wilberforce Road/Freemans Reach Road	Roundabout	17	B	17	B	17	B	19	B
Bridge Street/George Street	Traffic signals	25	B	169	F	24	B	30	C
Bridge Street/Macquarie Street	Traffic signals	25	B	99	F	23	B	83	F

The LoS results in Table 6-6 indicate that the proposed modifications to the approved design would reduce delays and improve LoS at Bridge Street / George Street and Bridge Street / Macquarie Street in the afternoon peak.

In the 2026 afternoon peak, the model predicted that proposed modifications would improve LoS at Bridge Street / George Street from Level of Service E with a delay of 62 seconds (approved design) to LoS B with a delay of 20 seconds (proposed modification design). At Bridge Street / Macquarie Street, the proposed modifications would improve intersection LoS from LoS E with a delay of 56 seconds (approved design) to LoS D with a delay of 48 seconds (proposed modification design).

In the 2036 afternoon peak, the proposed modifications would improve LoS at Bridge Street / George Street from LoS F with a delay of more than 169 seconds (approved design) to LoS C with a delay of 30 seconds. At Bridge Street / Macquarie Street intersection, the proposed modification

would reduce intersection delay from 99 seconds (approved design) to 83 seconds (proposed modification design).

6.3.4 Mitigation/management

Environmental management measures for the operation of the project have largely been incorporated into the design of the project.

Traffic management measures would be implemented for the proposed modification works in accordance with the approved *WBRP Construction Traffic Management Sub Plan* (Appendix B1 of the CEMP).

6.4 Historic and maritime heritage

6.4.1 Introduction

Historic and maritime heritage impacts were discussed in Section 7.1, *Working Paper 1 Historic Heritage Assessment and Statement of Heritage Impact* and *Working Paper 2 Maritime Archaeological Statement of Heritage Impact* of the EIS.

Subsequent to project approval, and in accordance with condition B3 and B4 of the MCoA, the following documents have been prepared with regards to historic and maritime heritage:

- Historical and Maritime Archaeological Research Design (AAJV, 2016a) – approved by DP&E June 2016;
- Test Excavation Report – Historical Archaeology (AAJV, 2017a) – approved by DP&E on 1 December 2017;
- Detailed Salvage Strategy for Aboriginal and Historical Archaeological Heritage (AAJV, 2017c) - approved by DP&E on 1 December 2017;
- Maritime Archaeological Testing Report and Detailed Salvage Strategy for Maritime Archaeological Excavation (Cosmos Archaeology, 2018) – approved by DP&E on 23 March 2018; and
- Heritage Mitigation and Options Report (AAJV, 2018a).

It is noted that components of the Detailed Salvage Strategy (AAJV, 2017c) have been undertaken, primarily salvage within lower Thompson Square. No construction work or salvage has been undertaken at the location of the proposed modification.

The *WBRP Construction Heritage Management Sub Plan* (Appendix B5 of the CEMP) was approved by DP&E 18 September 2018 and is currently implemented.

A review of the terrestrial heritage impacts of the proposed modification was undertaken by the AAJV and is provided in Appendix C.

The proposed modification would not alter the maritime heritage impacts during construction and operation compared to the current design and impacts identified in the EIS, and have not been considered further.

6.4.2 Existing environment

Windsor is one of the oldest towns in Australia as well as being one of the 'Macquarie towns'[1]. European settlement of the place now known as Windsor dates to soon after the arrival of the First Fleet and the establishment of Sydney in 1780s. It has evolved through several periods of economic and social change, and has developed a high public profile as a historic place.

Many items of historical heritage within and adjacent to the proposed modification are listed on statutory and non-statutory heritage registers in recognition of their significance. The modification is located in the Thompson Square Conservation Area (TSCA) and details of the listings are summarised in Table 6-7. The open space area of Thompsons Square has been subject to numerous changes since European settlement.

Table 6-7: Thompson Square statutory and non-statutory heritage listings

Name	Address/Description	Individual item listing	Conservation area listing
Thompson Square – Roads	Parts of Thompson Square, Bridge Street, Old Bridge Street, The Terrace and George Street.	LEP Part of I00126 RNE 3177	SHR #00126 (excluding cutting through Thompson Square) LEP C4 NT S10510
Thompson Square – Upper Parkland	Thompson Square, Lot 7007 DP 1029964	LEP Part of 100126 NR S11456 RNE 3167	SHR #00126 LEP C4 NT S11456 (reserves) and S10510 (precinct) under "Portion of land known as Thompson Square"
Thompson Square – Lower Parkland	1 Bridge Road, Lot 345 DP 752061. Also addressed as 3 Old Bridge Road and Thompson Square.	LEP Part of I00126 NT S11456 RNE 3167	SHR #00126 LEP C4 NT S10510 under "Portion of land known as Thompson Square"

SHR – State Heritage Register
RNE – Register of the National Estate
LEP – Hawkesbury Local Environmental Plan 2012
NT: National Trust

The TSCA SHR item (SHR item #00126) includes most of the properties within and surrounding Thompson Square, although two properties (Macquarie Arms Hotel and the House and outbuilding at 5 Thompson Square) are excluded from the area and listed as individual items. The main thoroughfare of Bridge Street, including the 1934 road between the kerbs down to where it meets The Terrace and Windsor Bridge, is also excluded from the SHR TSCA boundaries. An assessment of significance of the TSCA using the NSW heritage criteria is presented in the EIS. The assessment of significance concludes the TSCA to be State significant under all seven criteria and that its significance extends beyond the SHR boundary.

As part of the historic archaeological testing (AAJV, 2017a) under condition B3 of the MCoA four test pits were excavated in the vicinity of the proposed modification. These test pits are shown on Figure 6-3 and key finding of the archaeological testing are outlined in Table 6-8. Historical

[1] In November, 1810, Governor Macquarie set out to inspect the outer western Sydney districts, following the Hawkesbury and Nepean Rivers. Macquarie surveyed the available land and designated and named five settlements that would subsequently become known as the 'Macquarie Towns' – Windsor, Richmond, Castlereagh, Pitt Town and Wilberforce.

archaeological evidence was also found in Aboriginal test pits SA 8, SA 9 and SA 10 which are shown on Figure 6-6 and key findings are also summarised in the Table 6-8.

Table 6-8: Summary of key findings (Source: AAJV, 2017a)

Test pit	Key findings
Historic test pits	
SH 2	Bitumen road surface crossing Thompson Square, potentially mid to late 19th century. Disturbed historical deposit with artefacts dating from early to mid-19th century.
SH 3	Disturbed historical topsoil and subsoil deposits.
SH 4	No historical archaeological features, structure or artefacts identified.
SH 6	No historical archaeological features, structure or artefacts identified in test pits 1, 5, 6 and 7. The heavily disturbed brick feature in test pit 2 may be demolition of an early 19th century structure, or may relate to the brick drain seen in SA26. The brick feature in test pit 3 is likely to be remnant paving from the 1850s. The stratigraphy of test pit 4 is likely to contain an *in situ* but disturbed historical ground surface which may date back to the early 19th century. In summary, the overall area of SH 6 has been heavily disturbed, however pockets of undisturbed areas can still provide information.
Aboriginal Test Pits	
SA 8	A modified historical topsoil with a date range of 1830 – 1869, providing strong evidence that archaeology relating to the early settlement period of Windsor is likely to be preserved within lower Thompson Square, below later fill deposits.
SA 9	Historical deposits consistent with SA 8, providing strong evidence that archaeology relating to the early settlement period of Windsor is preserved within lower Thompson Square.
SA 10	Evidence of further modified historical topsoil and subsoil dating to the first half of the 19th century and consistent with the results of SA 8 and SA 9.

These excavation findings indicated that the site had the potential to contain significant archaeological remains and as such archaeological salvage was recommended in certain areas. The Detailed Salvage Strategy (DSS) (AAJV, 2017c) outlines the historical archaeological management zones (refer Figure 6-2a) including a staged salvage program (refer Figure 6-2b).

Area 1 (lower Thompson Square), Area 2, Area 3 (ii) and Area 3 (iii) have been fully salvaged for historical archaeological remains. The remaining areas of historical archaeological potential recommended for salvage are located within roadways, footpaths and other areas within the project area, including at the location of the proposed modification.

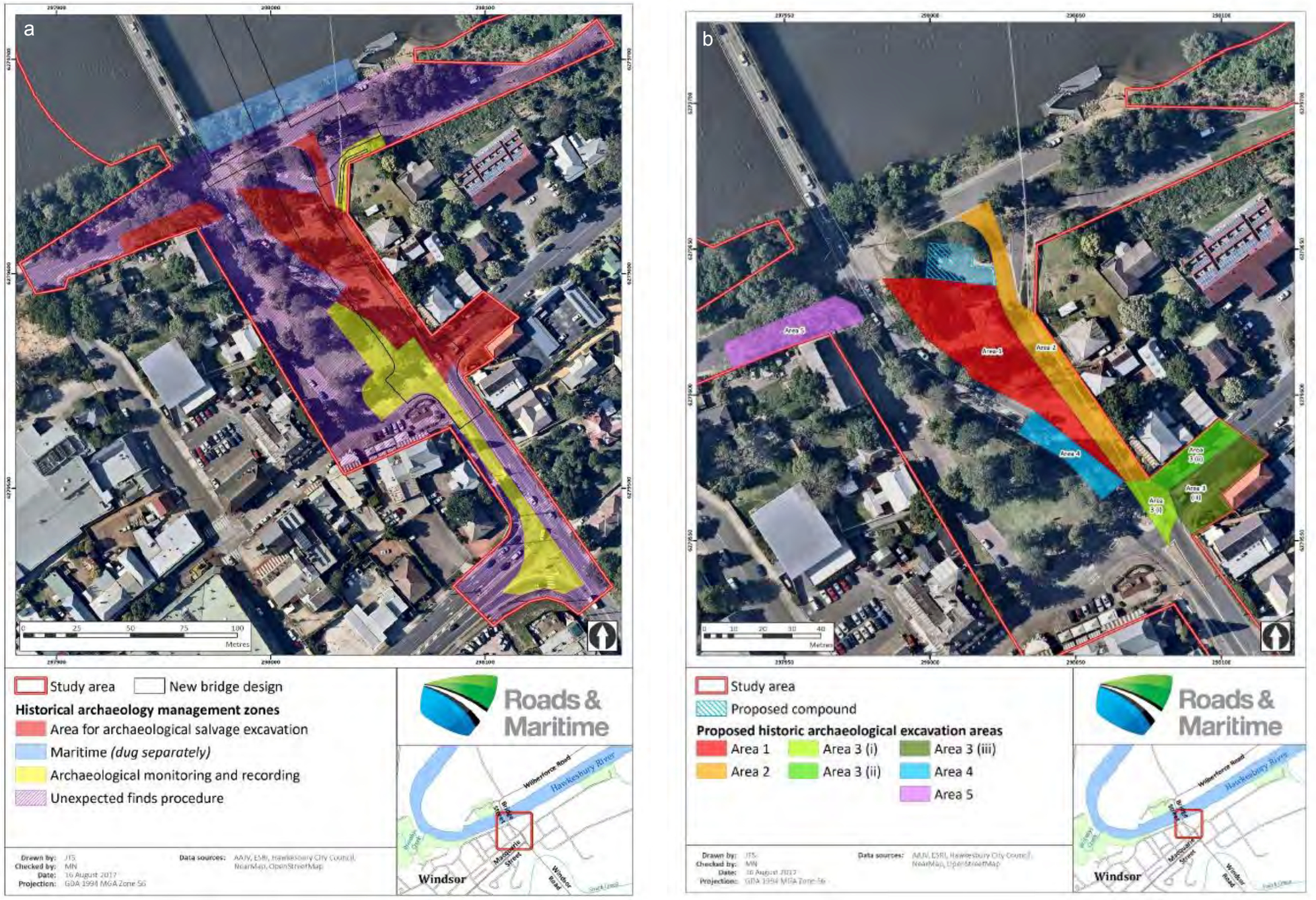


Figure 6-2: (a) Historical archaeological management zones (b) Proposed historical archaeological salvage excavation areas (Source: AAJV, 2017c)

6.4.3 Impact assessment

6.4.3.1 Historical Archaeological

The location of the proposed modification is within an area suspected to contain historical archaeological deposits and relics, based on the 2016 archaeological testing works (AAJV, 2017a).

Historical research has indicated historical usage in this part of Thompson Square was ephemeral in nature and archaeological testing revealed a very shallow depth of deposit in this general area, which may be disturbed by the construction of the proposed modification. This modification is partially within the area already identified for historical archaeological salvage (referred to as Area 1 and Area 4 in the DSS) or is within an area nominated for historical archaeological monitoring and recording or unexpected finds procedure (refer Figure 6-4). The area of the proposed modification would be managed in accordance with these recommendations.

6.4.3.2 Landscape and Boundary Heritage

The proposed modification would have an additional impact on the configuration of Thompson Square by encroaching on an additional 160 square metres of the eastern side of the parkland in Thompson Square. This impact would have no direct impact on above-ground historic features or landscape elements, however it would represent a further reduction in the size of the parkland Thompson Square compared to the approved project. The parkland in Thompson Square has been the subject of previous impacts and size reductions due to past road works. The heritage assessment determined that the cumulative impact of this design change is minor and within the context of the project and is acceptable from a heritage standpoint provided the migration/management measures identified in Section 6.4.4 are implemented. Refer Section 6.7 for further information.

6.4.4 Mitigation/management

The proposed modification does not change the recommendations for historical archaeological salvage and management outlined in the approved DSS (AAJV, 2017c). The proposed modification would be managed in accordance with the approved DSS and the approved *WBRP Construction Heritage Management Sub Plan* (Appendix B5 of the CEMP).

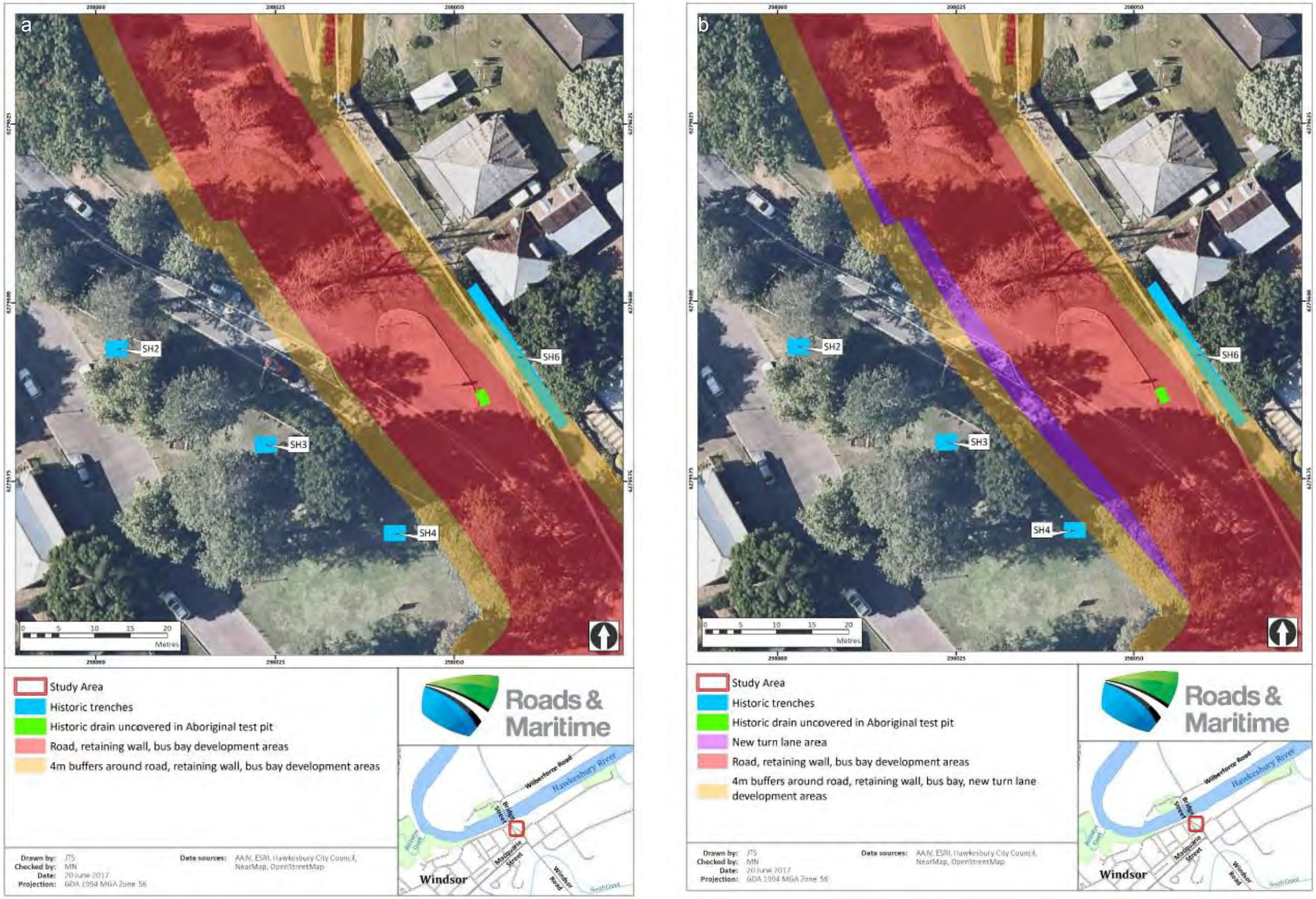


Figure 6-3: (a) Approved design and relationship to historic test pits (b) Proposed modification design and relationship to historic test pits

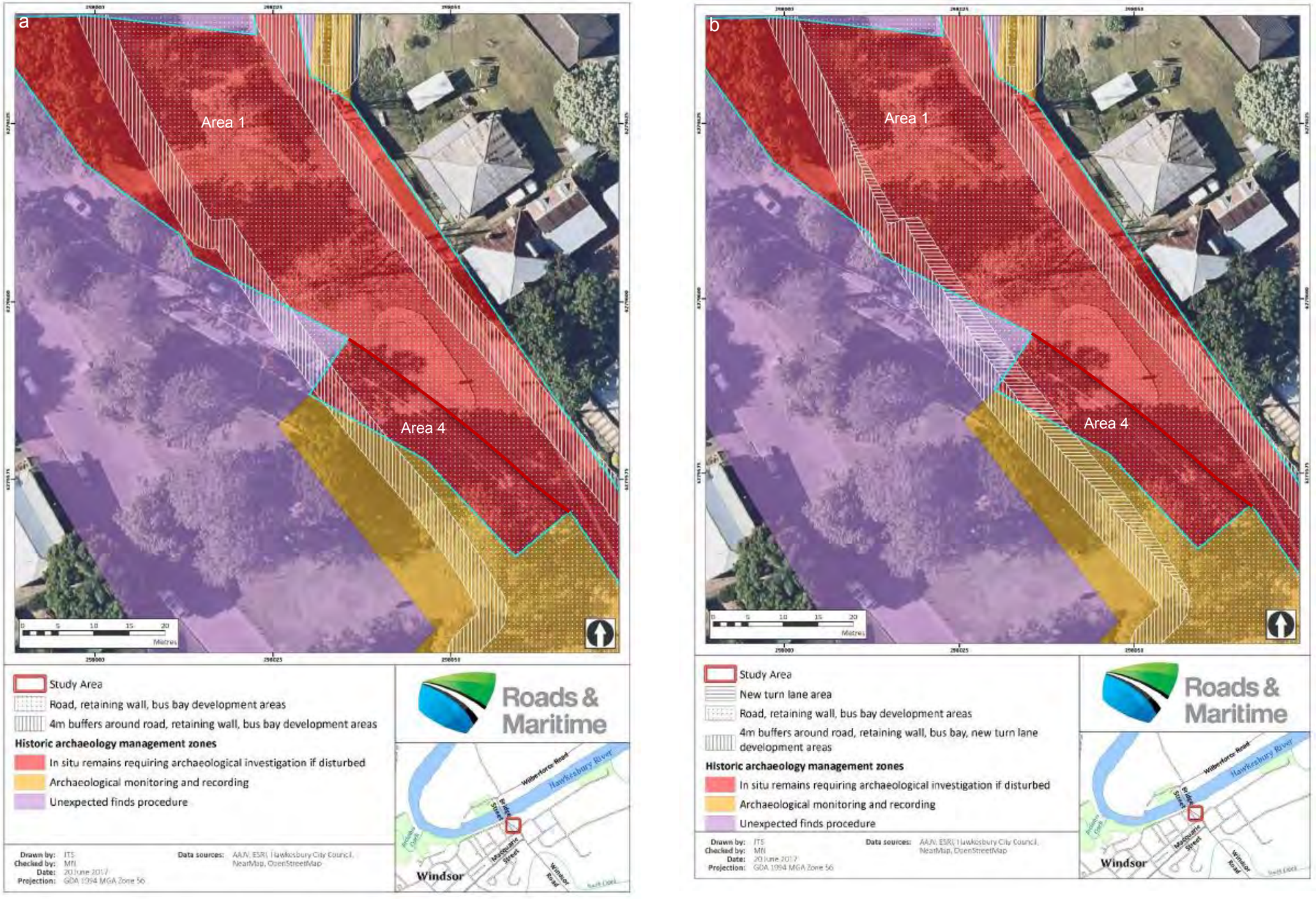


Figure 6-4: (a) Approved design and relationship to historical archaeological management recommendations (b) Proposed modification design and relationship to historical archaeological management recommendations

6.5 Aboriginal heritage

6.5.1 Introduction

Aboriginal heritage impacts were discussed in Section 7.2 of the EIS and in *Working Paper 3 Aboriginal Cultural Heritage Assessment Report.*

Subsequent to project approval and in accordance with Condition B3, B4 and C5 of the MCoA the following documents have been prepared with regards to Aboriginal heritage:

- Aboriginal Archaeological Research Design and Excavation Methodology (AAJV, 2016b) – approved by DP&E 13 July 2016;
- Test Excavation Report – Aboriginal Heritage (AAJV, 2017b) – approved by DP&E on 1 December 2017;
- Detailed Salvage Strategy for Aboriginal and Historical Archaeological Heritage (AAJV, 2017c) - approved by DP&E on 1 December 2017;
- Hawkesbury Region Sand Body Study - Research Design (AAJV, 2016c) – approved by DP&E on 8 August 2017;
- Hawkesbury Region Sand Bodies Study (AAJV, 2017d) – approved by DP&E on 1 December 2017; and
- Salvage Excavation Report – Aboriginal Heritage (AAJV, 2018b) – currently in draft.

The *WBRP Construction Heritage Management Sub Plan* (Appendix B5 of the CEMP) was approved by DP&E 18 September 2018 and is currently implemented.

A review of the heritage impacts of the proposed modification was undertaken by the AAJV and is presented in Appendix C.

6.5.2 Existing environment

The Hawkesbury-Nepean River corridor contains some of the earliest evidence of Aboriginal occupation in Australia. Excavations at TSCA have found evidence of Aboriginal occupation up to 33,000 years ago.

The proposed modification is located in the south-east corner of the parkland in Thompson Square in the vicinity of the following archaeological landscape (AAJV, 2017b):

- Ridgeline – a disparate shallow duplex soil profile, often beneath historical overburden, and containing discrete concentrations of Aboriginal objects up to 50/m^2. Much of this landscape has been heavily affected by modern and historical activities, with only pockets of soil profile (and any associated cultural material) being present across the landscape. The landscape encompasses the elevated areas in the vicinity of George and Bridge Streets, and extends into the upper part of Thompson Square – the latter area being where most of the cultural material was recovered from this landscape;
- Source bordering Dune: a fluvially and aeolian-derived sand body typically 1-1.5m in thickness, and extending across the upper and lower portion of Thompson Square, and into parts of Old Bridge Street, and The Terrace. A thin lense of the deposit is also located on the ridgeline east of the George/Bridge Street junction. The landscape is more intact in the upper Thompson Square, and has been subject to varying levels of burial by historical overburden and/or truncation from past activities. The deposit likely formed discontinuously between >82ka through to the mid-Holocene (~5ka). Archaeological material within this

deposit is extensive, and suggests two periods of visitation/occupation between 27-18ka (the onset and peak of the LGM), and the early- to mid-Holocene; and

- River's Edge Alluvium – a thick clay and fine sand alluvium encompassing the entire northern project area, and the lower areas of the southern project area, including The Terrace, the wharf area and surrounding carpark. This landscape was likely formed through low-energy fluvial deposition probably in the last 6.5ka, if not much more recently. Cultural material is found throughout the deposit in low numbers (<5/m^2), with many of them potentially re-worked either naturally or via human processes from other nearby archaeological landscapes.

As part of the Aboriginal archaeological testing (AAJV, 2017b) under condition B3 of the MCoA six test pits were excavated in the vicinity of the proposed modification. These test pits are shown on Figure 6-6 and results are outlined in Table 6-9.

Table 6-9: Results from test excavation in the vicinity of the proposed modification (Source: AAJV, 2017b)

Test Pit	Archaeological Landscape	Artefact Density (per m^2)	Overall test pit significance
SA 8	Source-Bordering Dune River's Edge – alluvium (<11m)	85.00	Very high
SA 9	Source-Bordering Dune	63.75	Very high
SA 10	Source-Bordering Dune	29.17	High
SA 11	Source-Bordering Dune	155	Very high
SA 12	Ridgeline	42	Moderate
SA 13	Ridgeline	3	Low

Following the test excavation program findings, it was considered that additional archaeological mitigations were warranted within the source-bordering dune archaeological landscape that may be impacted by the proposed development. The DSS (AAJV, 2017c) proposed to undertake manual excavation of 149m^2 within the source-bordering deposit in two large open area excavations in the vicinity of the four test pits (SA 8, SA 9, SA 10 and SA 29) which were shown to have a high artefact densities and/or other features of archaeological significance (refer Figure 6-5). This number represented approximately 10% of the potential impact, and provided an equitable balance between the volume of archaeological material that may be recovered, compared with the costs and time to undertake such works. The impact area includes the direct impact corridor of the road and a 4m buffer. The buffer was added on either side of the maximum designed bridge width to accommodate anticipated impacts plus construction-related indirect impacts, such as haulage roads, scaffolding, formwork, in the areas identified as most archaeologically sensitive.

The salvage program proposed in the DSS required substantial modifications and/or amendments due to unexpected disturbances which had resulted in the removal, reworking and/or loss of Aboriginal cultural material in the 19th century. This significant level of activity over the last 250 years across the lower Thompson Square parkland resulted in much of the original proposed salvage locations being too disturbed for Aboriginal archaeological excavation to occur.

These initial findings resulted in the archaeological salvage excavation of only those areas where in situ pre-colonial soil profiles were identified (refer Figure 6-5), totally 59m^2. Ultimately archaeological recovery of these deposits account for 100% of the surviving in situ soil profile within the impact corridor.

A significance assessment of the cultural deposits recovered (and those still present in other parts of the project area) show that they are of high (State) scientific significance, representing one of only a handful of examples of a Pleistocene ecological refuge used by Aboriginal people in the past, and having ongoing research potential

The main area where Aboriginal archaeological salvage excavation has been undertaken is within lower Thompson Square, outside the study area associated with the modification. Lower Thompson Square parkland has been heavily impacted upon by excavations for piers, pile caps, abutment walls and ancillary infrastructure.

6.5.3 Impact assessment

The proposed modification would encroach on the eastern side of the Thompson Square parkland. The additional area would form a tapered band along the western edge of the bridge approach, up to approximately three metres in width for a distance of approximately 100 metres. The entirety of this area is within the four metre impact buffer previously allowed for in the development of the archaeological management recommendations set out in the DSS (refer Figure 6-6a).

The proposed modification would draw the construction works closer to the area of highly significant Aboriginal archaeological sensitivity in terms of the preserved Pleistocene sand body within Thompson Square parkland (refer Figure 6-6b). The main area of sensitivity is in the vicinity of test pit SA11, which would remain outside the area of direct impact of the proposed modification. There would be no excavation or fill at SA 11.

Applying a four metre buffer zone beyond the approved project and proposed modification, as shown in Figure 6-6b, would result in the proposed works coming close to SA11 and its surrounding deposits (i.e. within three metres). While not directly impacted, test pits SA12 and SA13, containing a low to moderately significant ‘ridgeline archaeological landscape’ deposit, would now also fall within the revised buffer zone for the impact corridor. In order to increase the distance from construction areas to the area of Aboriginal sensitivity, the buffer zone in this area would be reduced to 1m, as indicated by the green areas shown on Figure 6-6b. Shallow excavation (<300mm) within the buffer zone would be required for battering of the slope and construction of the footpath,

Provided the mitigation measures identified below are implemented, additional Aboriginal archaeological impacts are not considered likely, and no changes to the recommendations of the DSS would be required.

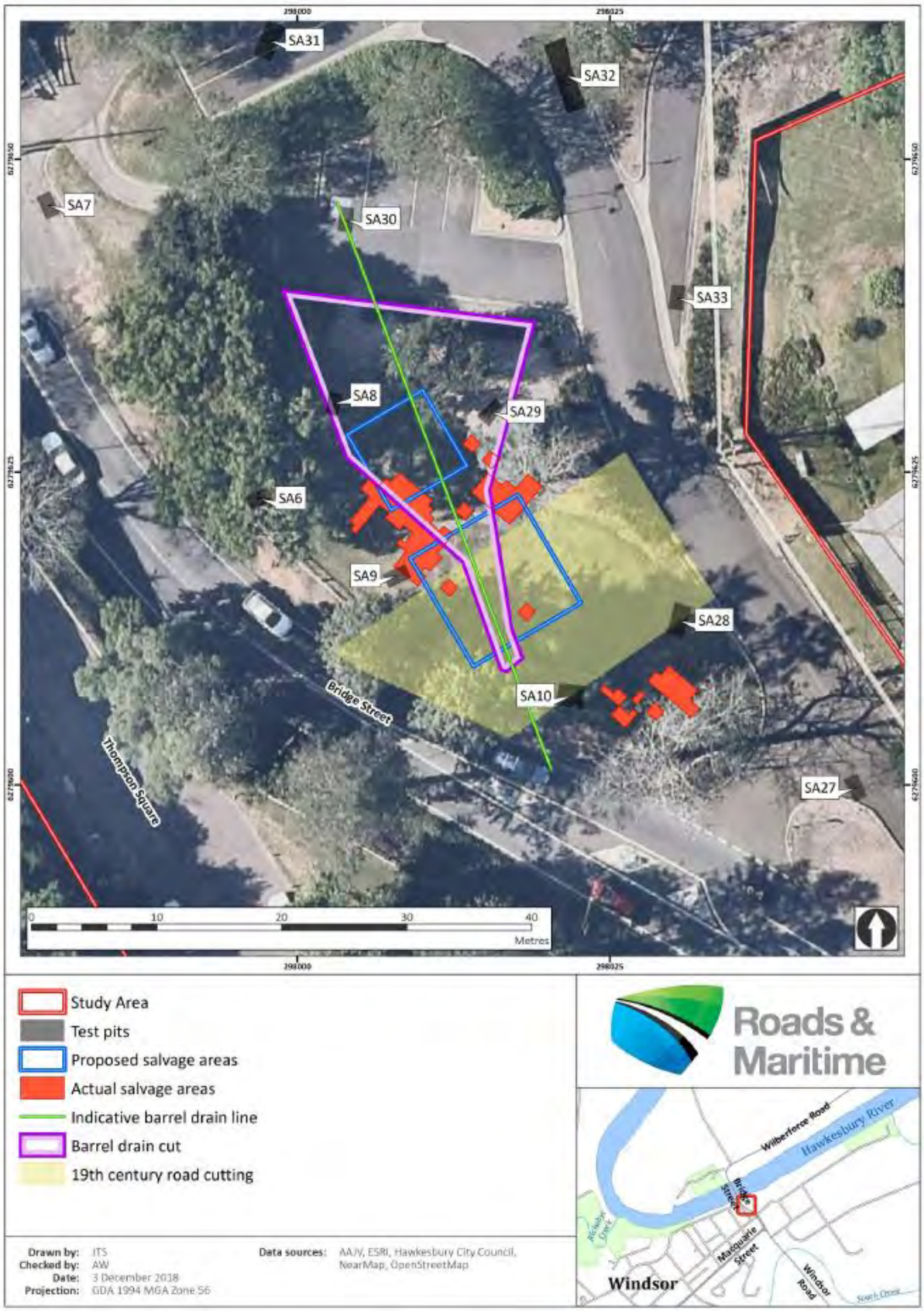


Figure 6-5: General location of proposed Aboriginal salvage areas outlined in the DSS and the actual salvage areas

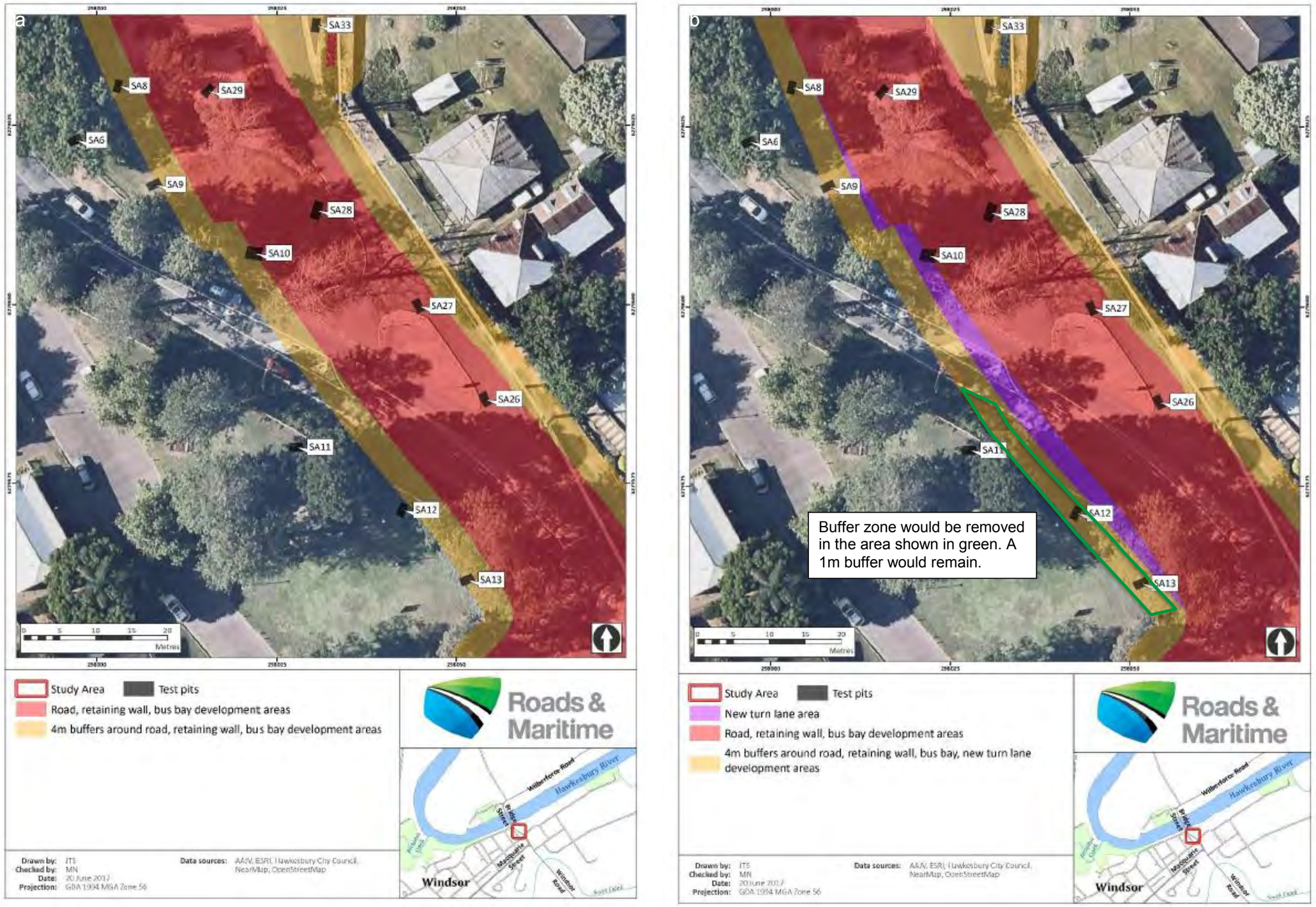


Figure 6-6: (a) Approved design and relationship to Aboriginal test pits (b) Proposed modification design and relationship to Aboriginal test pits

6.5.4 Mitigation/management

To ensure the archaeological sensitivities are protected within the vicinity of SA 11, the following mitigation measures would be incorporated into the *WBRP Construction Heritage Management Sub Plan* (Appendix B5 of the CEMP) in order to increase this distance from construction areas of Aboriginal sensitivity:

- The buffer zone would be reduced to 1m along its entire length (as marked in green on Figure 6-6b) and turned into a solid boundary through the use of temporary fencing to enforce a hard barrier which would not be crossed under any circumstances in order to increase the distance from construction areas to Aboriginal sensitivity;
- With the exception of shallow excavation (<300mm) no direct impact would be permitted within the buffer zone; and
- Indirect impacts must be appropriately managed (e.g. surface protection for heavy vehicles).

6.6 Planted Trees

6.6.1 Introduction

Flora and fauna impacts were discussed in Section 7.9 and in *Working Paper 10 Flora and Fauna* of the EIS. Planted trees were discussed in Section 7.4 and in *Working Paper 5 Urban Design and Landscape* of the EIS.

The *WBRP Construction Flora and Fauna Management Sub Plan* (Appendix B2 of the CEMP) was approved by DP&E 14 September 2018 and is currently implemented. The *WBRP Urban Design and Landscape Plan* (UDLP) was submitted to DP&E for information on 13 October 2017.

As part of this modification, an Arboricultural Impact Assessment (AIA) for a tree within Thompson Square was prepared by Tree Survey (2019) and is provided in Appendix D. The purpose of the AIA was to assess the current health and condition of the tree, evaluate the significance of the subject tree and its suitability for retention and provide recommendations for site specific tree-sensitive excavation/construction methods, and other measures which may mitigate the likely impacts of the proposed works.

6.6.2 Existing environment

The proposed modification is located in the south east corner of the upper Thompson Square parkland. The EIS classified the vegetation community in the study area as ‘parkland/landscaped areas’ in poor condition and was identified as having low ecological value. The study area was classified as ‘cleared grasslands’ with respect to fauna habitat.

Field surveys during preparation of the EIS did not identify any threatened ecological communities (TEC) in the project area (SKM, 2012).

Thompson Square parkland consists of mature trees, with no understorey and a completely maintained exotic grass cover. Mature trees of Thompson Square parkland include a number of Liquid Ambers (*Liquidambar styraciflua*), Silky Oaks (*Grevillea robusta*) and Kurrajongs (*Brachychiton populneus*) and one Hoop Pine (*Araucaria cunninghamii*). The stature of these trees suggests that some of them may be greater than 80 years in age.

The Urban Design and Landscape Plan (UDLP) prepared during detailed design outlines the trees within Thompson Square to be retained and the trees to be removed as shown in Figure 6-8. The

existing trees within Thompson Square which will be retained as part of the approved project and which are located in close proximity to the proposed modification are listed in Table 6-10 and shown in blue on Figure 6-8.

Table 6-10: Retained trees within Thompson Square parkland (Source: SKM, 2012)

ID	Species	Common name	Approved design (EIS)	Design including modification
T4	*Brachychiton populneus*	Kurrajong	Retained	No change
T5	*Brachychiton populneus*	Kurrajong	Retained	No change
T11	*Araucaria cunninghamii**	Hoop Pine	Retained	No change
T12	*Grevillea robusta*	Silky Oak	Retained	No change

* *It is noted that the species of this tree was incorrectly identified as an Araucaria bidwillii (Bunya Pine) in the Windsor Bridge EIS - Urban Design Working Paper.*

The *Araucaria cunninghamii* tree (refer Figure 6-7) is located towards the north-eastern boundary of Thompson Square adjacent to Bridge Street immediately adjacent to the proposed modification (referred to as 'T11" in Figure 6-8). The following observations were made during the site inspection on 5 July 2019 (Tree Survey, 2019):

- The overall health and condition of the tree is good. The canopy is thick and shows little signs of discolouration and dieback;
- The tree is 28 metres in height, with a canopy spread of 14 metres and a trunk diameter at breast height (DBH) of 1.3 metres;
- The tree protection zone (TPZ) for this tree has been calculated at 15 metres radius from the centre of the trunk; and
- The structural root zone (SRZ) has been calculated at 3.7 metres radius from the centre of the trunk (or 3 metres from the edge of the trunk).

Figure 6-7: Existing *Araucaria cunninghamii* tree located towards the north-eastern boundary of Thompson Square (Source: Tree Survey, 2019)

Figure 6-8: Existing and proposed tree planting (Source: Detailed Design UDPL drawing set)

6.6.3 Impact assessment

The proposed modification works are not anticipated to impact trees T4 and T5 located along the southern boundary of Thompson Square, nor tree T12 located at the eastern end of Thompson Square.

The road alignment of the proposed modification is located far enough away from the *Araucaria cunninghamii* tree (T11) that it would not cause any significant impacts. However, the proposed batter located between the edge of the proposed road alignment and the tree may have potential to cause impacts if a tree sensitive design is not utilised.

The top of the existing batter is located three metres from the trunk of the tree and provides an excellent delineation for the SRZ. It also defines the minimum distance between any proposed works and the subject tree. The closest point of any excavation should be located at least three metres from the subject tree (measured from the edge of the trunk). Any excavations that fall beyond the three metres delineation would require further investigation through the use of non-destructive excavation under supervision of the project arborist.

6.6.4 Mitigation/management

The proposed modification would be managed in accordance with the approved *WBRP Construction Flora and Fauna Management Sub Plan* (Appendix B2 of the CEMP). In addition, the following mitigation measures would be implemented:

- The proposed batter located between the proposed road alignment and the *Araucaria cunninghamii* tree will be undertaken via one of the following methods, unless otherwise approved by Roads and Maritime:
  - Option 1: All proposed work is located at least three metres from the subject tree (measured from the edge of the trunk). This option would not require further root investigation or assessment by the project arborist. The design of the modification has adjusted the batters to reduce the extent of excavation in the vicinity of the tree; or
  - Option 2: The proposed work falls within three metres of the subject tree (measured from the edge of the trunk). This option would require further root investigation (by non-destructive methods) under supervision of the project arborist. Any proposed excavations that fall within 2.5 metres of the tree are not recommended and are likely to cause impacts that cannot be mitigated through the use of tree protection measures and/or tree sensitive construction techniques; and
- Ensure the overhanging canopy of the *Araucaria cunninghamii* tree is protected and retained as its shape is important for its aesthetic appearance.

6.7 Visual amenity, urban design and landscape

6.7.1 Introduction

Visual amenity, urban design and landscape impacts were discussed in Section 7.4 of the EIS and in *Working Paper 5 Urban Design and Landscape Concept Report.* The *WBRP Urban Design and Landscape Plan* (UDLP) was submitted to DP&E for information on 13 October 2017.

A desktop review of the landscape character and visual impacts of the proposed modification was undertaken by the Spackman Mossop Michaels (SMM) and is presented in Appendix E.

6.7.2 Existing environment

6.7.2.1 Landscape character

'Landscape character is the aggregate of built, natural and cultural aspects that make up an area and provide its unique sense of place. Landscape in this context is taken to include all aspects of a tract of land - the built, planted and natural topographical and ecological features.'

The zones correspond to landscape character types in the area and allow for a more detailed discussion of the character of each zone, the project and the likely impact on the landscape character to be experienced as a result of the project. Each zone in the EIS was defined through the development of an understanding of urban form, topography, and vegetation in combination with other factors, such as land use activities.

Three landscape character zones (LCZ) were identified in the EIS. The proposed modification is located within LCZ 1. The zone is described in the following section.

LCZ1 - Thompson Square

The parkland of Thompson Square dominates the landscape character of LCZ 1. This landscape is characterised by large mature ornamental trees which contrast markedly with the urban surroundings of Windsor. The parkland is generally defined by surrounding buildings on three sides and roadways on all four sides. The parkland is also diagonally dissected from east to west by Bridge Street, providing vehicular access to the existing bridge, and its deep cutting, physically and visually separating the space into two distinct open space areas.

The buildings surrounding Thompson Square comprise of one and two storey colonial buildings and are set around three sides of the park. The recently restored buildings provide a strong physical edge and sense of containment to the square, as well as a unified heritage quality, which together form the Thompson Square Conservation Area.

The upper area of Thompson Square offers the best amenity with easy access to the adjoining retail outlets on George Street. The upper area consists of a generally level open grassed area with a number of mature trees planted informally around the space, providing an attractive, enclosed parkland setting. Park furniture is scattered around this area providing picnic facilities for casual use. The Memorial and white rail on edge fencing add a civic quality to the area. The cutting provides a degree of visual separation from Bridge Street and its constant traffic.

The lower area is of low landscape amenity with poor pedestrian access due to the steeper grades and road infrastructure, including a small carpark. The topography has been artificially mounded, forming a small promontory that offers views out towards the river and opposing riverbank and provides the only usable green space.

Parkland area

The approved project which is currently under construction, will reunite the upper and lower sections of the parkland in Thompson Square with the removal of the current Bridge Street alignment connecting to the existing bridge.

The first span of the current bridge will be retained as a viewing platform and The Terrace which runs parallel to the river, will be converted to a slow speed shared zone with a speed limit of 10kph and raised brick road surface to match the paths around the Square. This will have the effect of extending the Thompson Square parkland into a corridor of continuous open space between George Street and the Hawkesbury River.

As a result of these changes, the expanded parkland will increase the extent of usable recreation space with higher levels of amenity than the existing situation. The parkland will not only have better visual connections to the river but also have better physical connections between George Street and the river. This will have the effect of expanding the areas of high amenity parkland within Thompson Square.

6.7.2.2 Visual catchment

The EIS determined the area from where the proposed works would be visible, defined as the Visual Envelope Map (VEM), as illustrated in Figure 6-9. The EIS assessed the potential visual impact of the project in relation to 18 viewpoints within the project area. The viewpoints of relevance to the proposed modification are viewpoints 3, 4, 5, 6 and 7 as shown in Figure 6-9 and described in Table 6-11.

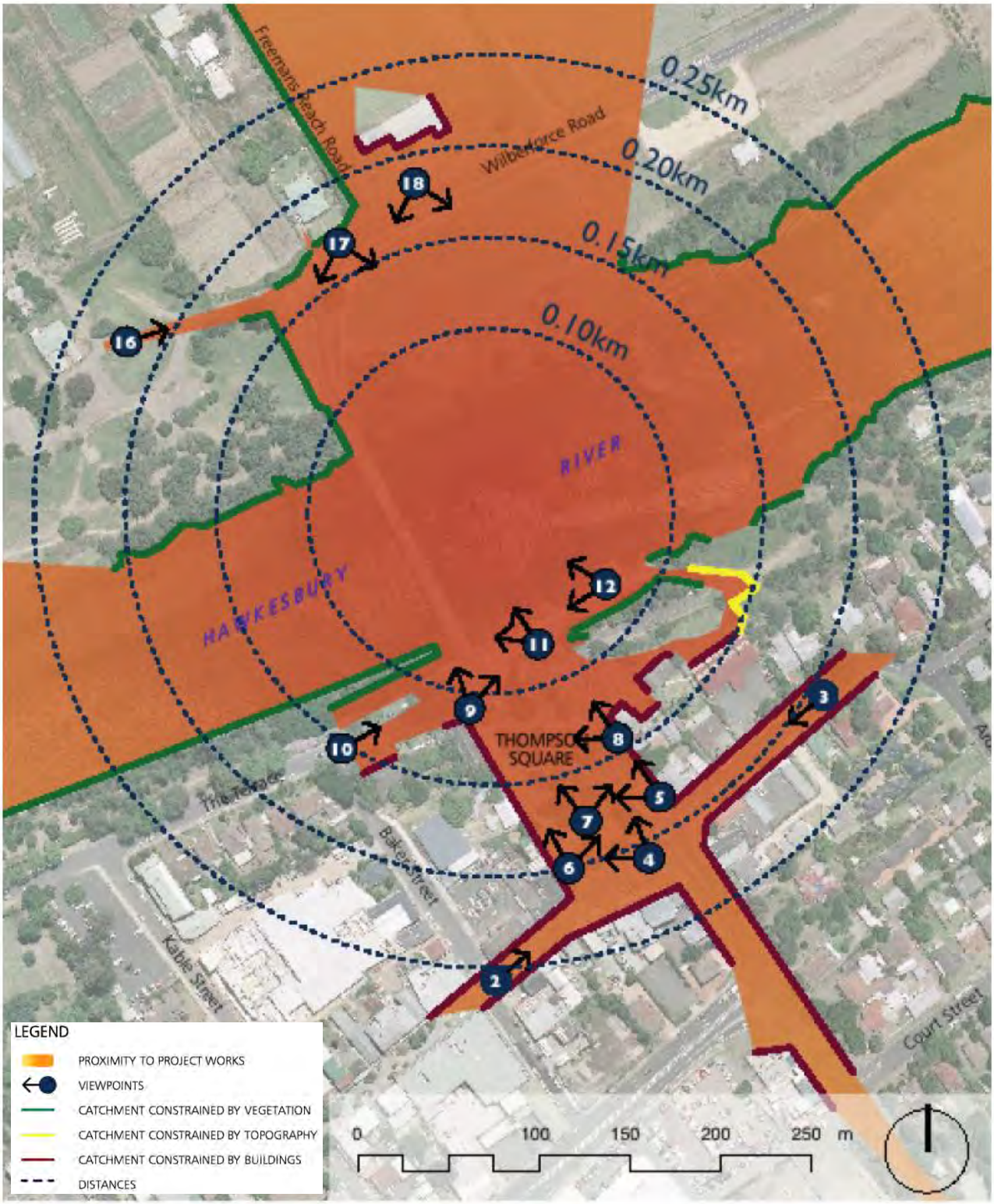


Figure 6-9: The Visual Envelope Map (VEM) and location of key viewpoints at a location scale (Source: SKM, 2012)

6.7.3 Impact assessment

6.7.3.1 Landscape character impact

LCZ1 – Thompson Square

The desktop assessment found that the modification would impact on LCZ 1: Thompson Square.

The EIS identified the landscape character sensitivity of LCZ 1 to be High and the magnitude of the impacts from the upgrade to be High to Moderate, giving an overall landscape character impact of High. The high sensitivity rating is based on the cultural heritage values of the built form surrounding Thompson Square and the intervening open space which includes the parkland with mature trees which creates high value recreational amenity. Section 7.4 of the EIS defines 'sensitivity' and 'magnitude' for the purposes of the landscape character impact assessment and outlines the impact assessment grading matrix.

The proposed modification would increase the width of Bridge Street by a maximum of three metres compared to the approved project. This would have a minimal impact on the magnitude rating, which would remain High to Moderate. Therefore, the landscape character impact to LCZ 1 would remain High.

Parkland area

The area of parkland that would be directly affected by the proposed modification is located adjacent to Bridge Street. The highest value parkland from an amenity and usage perspective is in the central area of the parkland which offers not only some increased separation from the road but also an elevated setting providing views over the parkland and road to the river and floodplain beyond (refer Figure 6-10).

Figure 6-10 shows the edges of the parkland that are affected by their proximity to both Bridge Street and the road in Thompson Square from an amenity and usage perspective. Along both of these parkland edges are landscape areas which separate the higher value amenity parkland areas from the adjacent roads. The Bridge Street frontage has a wider area as it is adjacent to a main road whereas the road in Thompson Square is a slow speed one way road with brick pavement. The retained trees and the proposed new tree planting along the Bridge Street frontage will assist in maintaining the high amenity values in both the central area of the parkland and the areas adjacent to Bridge Street.

The additional merge lane would reduce the area of parkland by a maximum of three metres in width over approximately 70 metres of parkland frontage, and this would potentially have some effect on the higher amenity central areas as the edge of Bridge Street moves into the southern section of the parkland.

However, Figure 6-10 shows the majority of the area of parkland is retained and the physical access and view corridor through to the river is also unaffected.

All of the trees, existing and proposed, identified to be retained and planted in the current approved project would be retained in the proposal for the modification. A number of additional trees could be planted along the frontage of Bridge Street if an increased level of separation is required, subject to consultation with Hawkesbury City Council.

Approximately 160 square metres or approximately 5% of the grassed area in the Thompson Square parkland would be removed and replaced with additional road pavement. As a

consequence, the degree of change between the existing and the proposed merge lane would be relatively moderate.

Wider project area

Once construction and rehabilitation of the approved project (including modification) has been completed, there would be an overall increase in the area of usable public space both on the northern and southern side of the river.

On the northern side of the river, land acquired which is not directly in the operational project footprint and the northern approach road to the existing bridge would be landscaped. Paths linking the shared path on the new bridge to Macquarie Park would also be provided. This would create about 1400 square metres of additional accessible usable open space directly adjacent to Macquarie Park (SKM, 2012).

The Terrace would also be rejoined providing continuous access along the foreshore. The foreshore area associated with Windsor Wharf would also be reopened to public access with only a minor loss of area (less than five per cent of the lot) compared to the existing situation (SKM, 2012).

Figure 6-10: Plan of Thompson Square illustrating the retained high amenity parkland and the notional landscape buffer

Photomontages

Photomontages were prepared to illustrate the degree of visual contrast between the approved lane configuration and the proposed merge lane configuration on Bridge Street. Two viewpoints were chosen to show the areas of greatest visual change along the edge of Thompson Square. The location of the two viewpoints for are shown in

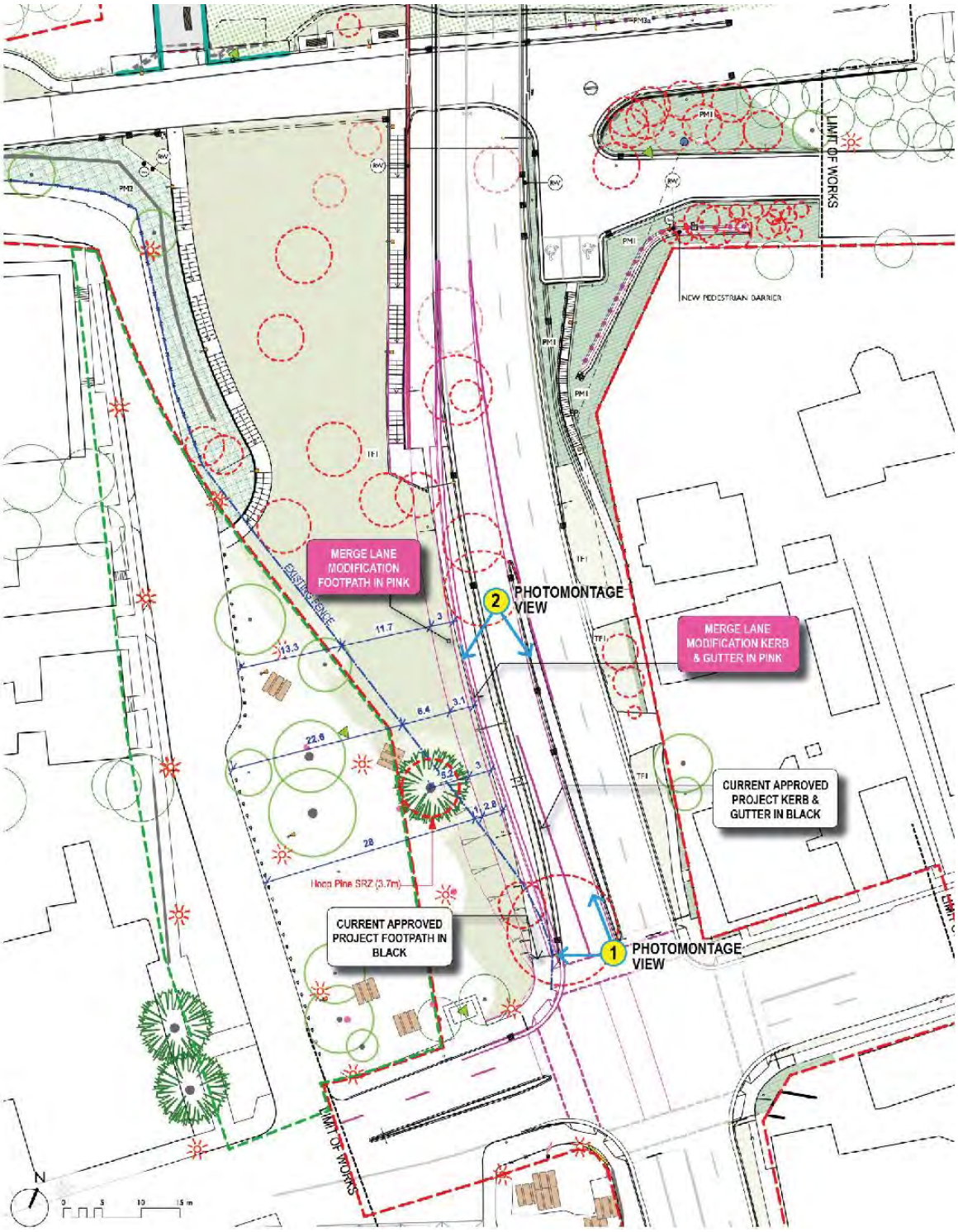


Figure **6-11**. The photomontages are shown in Figure 6-12 to Figure 6-15.

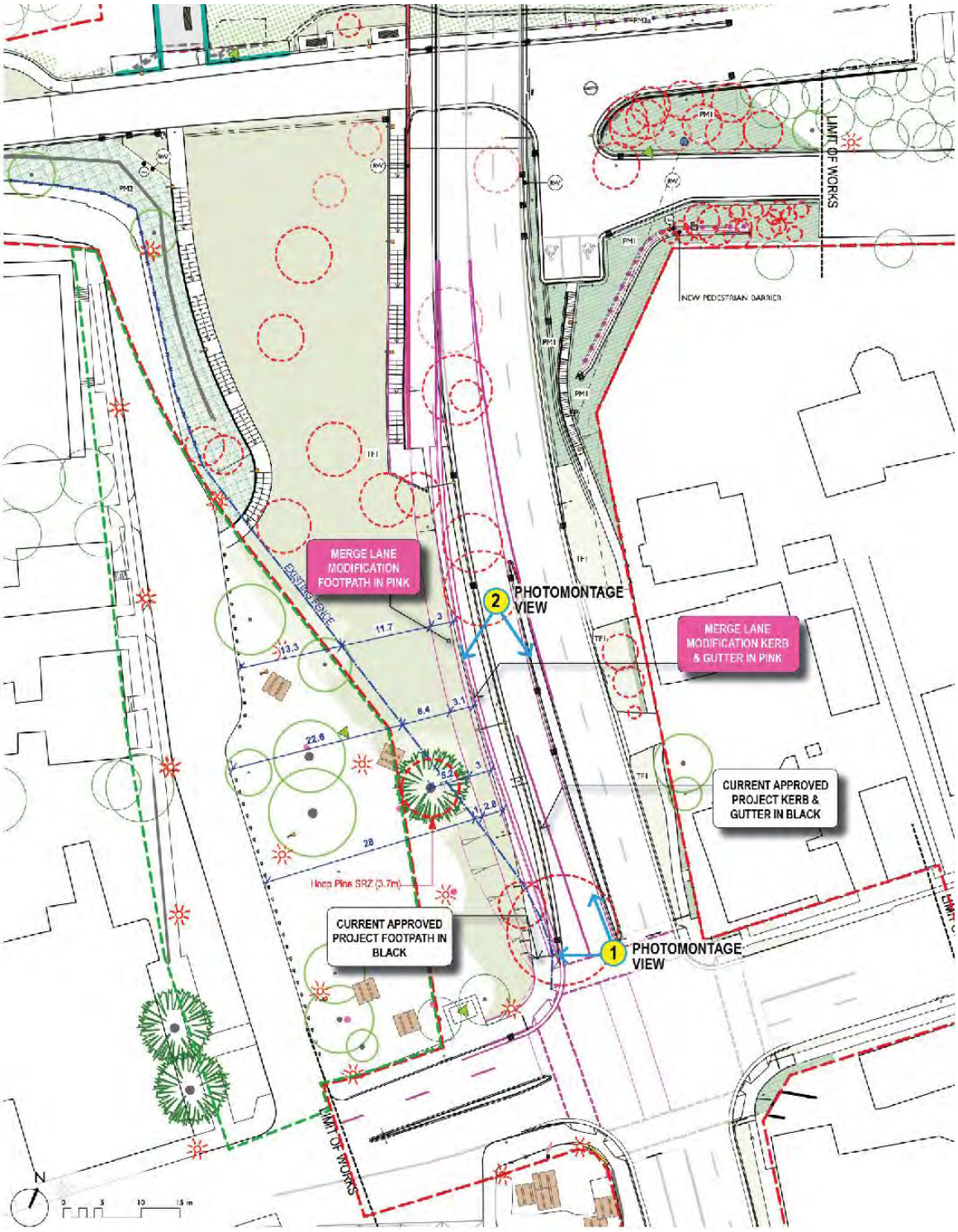


Figure 6-11: Location of viewpoints used for visualisation

Figure 6-12: View 1 - Visualisation of the approved project on Bridge Street (looking north-west)

Figure 6-13: View 1 - Visualisation of the proposed modification on Bridge Street (looking north-west)

Figure 6-14: View 2 - Visualisation of the approved project on Bridge Street (looking south east)

Figure 6-15: View 2 - Visualisation of the proposed modification on Bridge Street (looking south east)

6.7.3.2 Visual impact

The desktop assessment found that the modification would affect five of the 18 viewpoints assessed for the original Project, namely: viewpoints 3, 4, 5, 6 and 7 as outlined in Table 6-11.

As described in Table 6-11, the proposed changes would marginally increase the magnitude ratings of Viewpoints 5 and 7, however, this would not be sufficient to increase the overall visual impact ratings identified in Section 7.4 of the EIS. Section 7.4 of the EIS defines 'sensitivity' and 'magnitude' for the purposes of the visual impact assessment and outlines the impact assessment grading matrix.

6.7.4 Mitigation/management

A number of mitigation measures are provided in the EIS to be included in the detailed design phase of the project, aimed at reducing the impact of the approved project on the existing character of Thompson Square.

In addition to these, additional tree planting along the parkland edge of Bridge Street should be considered, in consultation with Hawkesbury City Council, if additional visual separation is required between the parkland and the road.

Mitigation measures relating to maintaining the health of the *Araucaria cunninghamii* (Hoop Pine) within Thompson Square parkland are provided in Section 6.6.

Table 6-11: Visual impact assessment

Viewpoint No. and Location	Description	Impact Assessment of Modification
Viewpoint 3 George Street, 100 metres east of Bridge Street, looking south west 	This section of George Street is predominately residential with two motels nearby. There is a slight slope away from the Bridge Street intersection.	The modification would not change the sensitivity rating assessed in the EIS, which would remain Low. Due to the distance of the viewer from the modification, there would be no change to the magnitude of the visual impact, assessed as Low in the EIS. Therefore, the overall visual impact rating would remain Low.
Viewpoint 4 Seating area on south side of George Street, near Bridge Street intersection, looking north west. 	Located at the eastern end of Windsor's retail precinct, with a mix of cafes and restaurants, opposite Thompson Square. There is an underutilised, small raised seating area, separated from George Street by a low Box hedge. The trees in Thompson Square provide shade to this area in the afternoon and limit views to the north towards the river. The Memorial and white rail edge fencing add a civic quality to the area.	The modification would not change the sensitivity rating assessed in the EIS, which would remain High. The modification widens Bridge Street by approximately three metres compared to the approved project, however, no additional trees are proposed to be removed. The increased road width would not be apparent from this viewpoint as Bridge Street north slopes away below the ridgeline, maintaining a Moderate magnitude rating. Therefore, the overall visual impact rating would remain High to Moderate.

Viewpoint No. and Location	Description	Impact Assessment of Modification
Viewpoint 5 Bridge Street, at the entrance to the former River Music, looking north west. 	Bridge Street begins to descend to the river foreshore and divides into Bridge Street (connecting to Windsor Bridge) and Old Bridge Street at this location. Three buildings front Old Bridge Street, including the historic building that housed the former River Music. A low vegetated embankment, to the edge of Thompson Square, sits opposite.	The modification would not change the sensitivity rating assessed in the EIS, which would remain High. The modification widens Bridge Street by approximately three metres compared to the approved project, however, no additional trees are proposed to be removed. The increased road width would be noticeable from this viewpoint, however, would not be sufficient to increase the existing Moderate magnitude rating. Therefore, the overall visual impact rating would remain High to Moderate.
Viewpoint 6 Thompson Square, at the entrance to Macquarie Arms Hotel, looking north. 	The historic Macquarie Arms Hotel is located opposite the Thompson Square road at the corner of George Street. It overlooks the treed parklands and Memorial and the buildings to the north eastern side of the Thompson Square parkland. There are glimpses to the river and the existing bridge through the trees.	The modification would not change the sensitivity rating assessed in the EIS, which would remain High. The Proposal widens Bridge Street by approximately three metres compared to the approved project, however, no additional trees are proposed to be removed. The increased road width would not be apparent from this viewpoint due to the intervening landform in the park, retaining the existing Moderate magnitude rating. Therefore, the overall visual impact rating would remain High to Moderate.

Viewpoint No. and Location	Description	Impact Assessment of Modification
Viewpoint 7 Thompson Square parkland looking north. 	The centre of Thompson Square parkland is a shady, grassed area with a number of picnic tables and benches scattered around. A white rail on edge fence and small embankment separates the park from Old Bridge Street. Glimpses of the river are evident through the trees.	The modification would not change the sensitivity rating assessed in the EIS, which would remain High. The Proposal widens Bridge Street by approximately three metres compared to the approved project, however, no additional trees are proposed to be removed. The increased road width would be noticeable from this viewpoint as the top of the embankment moves up to 3 metres closer to the viewpoint, however, the magnitude rating would remain High to Moderate. This would maintain the overall visual impact rating as High.

6.8 Noise and vibration

6.8.1 Introduction

Noise and vibration impacts of the approved project were discussed in Section 7.5 and in *Working Paper 6 Noise and Vibration* of the EIS. The *WBRP Construction Noise and Vibration Management Sub Plan* (Appendix B3 of the CEMP) was approved by DP&E on 19 September 2018 and is currently implemented.

A review of the noise impacts of the proposed modification was undertaken by the Jacobs and is presented in Appendix F.

6.8.2 Existing environment

6.8.2.1 Existing noise and vibration

The primary noise source in the vicinity of the proposed modification is road traffic noise from Bridge Street. There are no industrial noise influences at this location.

Road traffic is the primary source contributing to vibration levels in the project area. These vibration levels would not be perceptible to humans and would not cause damage to heritage structures.

6.8.2.2 Identification of sensitive receivers

The sensitive receivers located in proximity to the proposed modification comprises a mix of residential, commercial (including heritage buildings) and recreational users as shown on Figure 6-16.

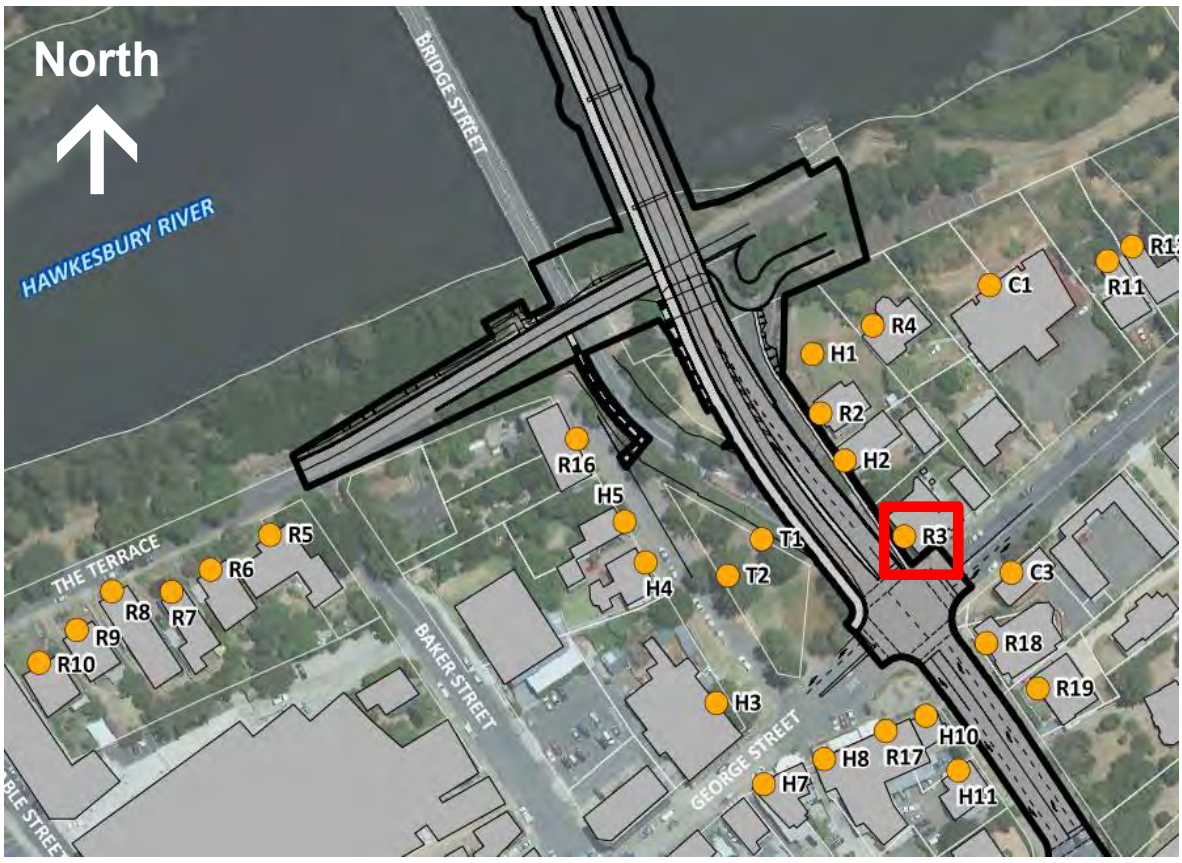


Figure 6-16: Location on sensitive receivers (Source: SKM, 2013)

The residential receiver potentially most affected by the proposed modification is residential receiver – R3.

Receivers immediately west of the proposed modification are heritage commercial premises ("H" receivers) or passive recreational areas ("T") within Thompson Square parkland, and are less acoustically sensitive types than residential receivers. T1 is representative of users of the parkland close to the existing road, with T2 being in the parkland at the furthest distance from the alignment. Thompson Square is currently subject to high levels of traffic noise from Bridge Street, Windsor Bridge and to a lesser extent George Street.

6.8.3 Impact assessment

6.8.3.1 Noise

The construction noise impacts associated with the proposed modification works are not considered to represent a significant difference to those identified in the EIS.

The prediction of daytime (15 hour) and night time (9 hour) noise level change to receiver R3 was determined using the UK Department of Transport, Calculation of road Traffic Noise (CoRTN, 1988) algorithms. The calculation algorithm allows for traffic volume and mix, type of road surface, vehicle speed, road gradient and ground absorption. This noise assessment of the proposal is based on traffic volumes for the year of opening (2026) as provided Arcadis (2018).

The predicted total traffic noise level to receiver R3 resulting from the approved design (without merge lane) and from the proposed modification (with merge lane) are presented in Table 6-12. The table indicates that no change to the total traffic noise level to receiver R3 would result due to the addition of the merge lane.

Table 6-12: Predicted noise impacts at receiver R3

Lane	Predicted Road Traffic Noise – dB(A)	
	Daytime ($L_{Aeq, 15hour}$)	Night-time ($L_{Aeq, 9hour}$)
Original Bridge Street Design (without merge lane)		
Northbound Lane	71.1	61.4
Southbound Left Lane	73.1	67.2
Southbound Right Lane	71.4	65.5
Total noise level	***76.7***	***70.1***
Revised Bridge Street Design (with merge lane)		
Northbound Merge Lane	62.7	52.4
Northbound Right Lane	70.3	60.7
Southbound Left Lane	73.1	67.2
Southbound Right Lane	71.4	65.5
Total noise level	***76.7***	***70.1***

Changes in noise levels within the recreational areas of Thompson Square would be minor; levels in the southern portion would increase due to the relocation of traffic lanes westward at the Bridge Street and George Street intersection, however levels would reduce in the north as the design increases separation distances to the design.

6.8.3.2 Vibration

As vibration from construction activities would rapidly dissipate with distance from its origin, only sensitive receivers adjacent to construction sites would be potentially impacted.

No operational vibration impacts are expected as a result of the proposed modification. Vibration from the operation of the project would not exceed human comfort or building damage criteria at adjacent buildings.

6.8.4 Mitigation/management

Mitigation / management measures for the approved project are relevant to the proposed modification. No additional mitigation measures are required.

The proposed modification would be managed in accordance with the approved *WBRP Construction Noise and Vibration Management Sub Plan* (Appendix B3 of the CEMP).

6.9 Land use, property and socio-economic

6.9.1 Introduction

Land use, property and socio-economic impacts were discussed in Section 7.8 and in *Working Paper 9 Land use, property and socio-economic* of the EIS.

6.9.2 Existing environment

The project is located adjacent to the town centre of Windsor in the Hawkesbury Local Government Area (LGA). Thompson Square is located in the town centre of Windsor, adjacent to the proposed modification. Thompson Square is a recreational area used for a variety of informal and formal uses. The square comprises a small area of open space with picnic tables and gardens, and is surrounded by historic buildings. The square is an important area for both the local community and tourism.

The EIS provides as outline of the socio-economic profile of Windsor and the broader Hawkesbury LGA.

6.9.3 Impact assessment

The proposed modification would bring construction works slightly closer to the recreational users of Thompson Square leading to reduced amenity as a result of construction noise, dust and the visible presence of construction sites and activities.

During operation the traffic would be brought closer to the recreational users of Thompson Square also leading slightly to reduced amenity. Based on the noise assessment (refer Section 6.8) changes in noise levels within these recreational areas would be minor; levels in the southern portion would increase due to the relocation of traffic lanes westward at the Bridge Street and George Street intersection, however levels would reduce in the north as the design increases separation distances to the design.

There would be a permanent partial loss of parkland in Thompson Square (refer Section 6.7).

The proposed modification would not change the tourism, economic impacts to local businesses or land acquisition requirements during construction and operation compared to the current design and impacts identified in the EIS.

All the land impacted by the proposed modification is either owned by Roads and Maritime already or is part of the local roads of the area. No further acquisition work or requirement of leasing of additional land is necessary for the area of the proposed modification.

6.9.4 Mitigation/management

Mitigation and management measures for the approved project are relevant to the proposed modification. No additional mitigation measures are required.

6.10 Soils, sediments, water and waste

6.10.1 Introduction

Soils, sediments, water and waste impacts were discussed in Section 7.6 and in *Working Paper 7 Soil, Sediments, Water and Waste* of the EIS.

The *WBRP Construction Soil and Water Management Sub Plan* (CSWMP) (Appendix B4 of the CEMP) was approved by DP&E 14 September 2018 and is currently implemented. The CSWMP is supported by the *WBRP Contaminated Land Management Plan* (Appendix B8 of the CEMP) and the *WBRP Construction Acid Sulfate Materials Management Plan* (Appendix B10 of the CEMP) which are also both currently implemented.

6.10.2 Existing environment

Based on previous studies the following is noted in relation to the area of the proposed modification:

- Soil landscape maps indicate the soil in the vicinity of the study area are classified as Berkshire Park (9030bp) and Freemans Reach (9030fr) based on the 'Soil Landscapes of the Penrith 1:100 000 Sheet' (Bannerman & Hazelton, 1990).These soil landscapes can be highly erodible;
- There is potential for coal tar to be found in the existing road pavements as outlined in the *WBRP Construction Contaminated Land Management Plan* (Appendix B8 of the CEMP); and
- No identified acid sulfate risk or potentially hazardous materials. (SKM, 2012).

6.10.3 Impact assessment

The proposed modification would involve a slight increase of 'cut' earthworks into Thompson Square. However, this minor additional volume would be considered consistent with the expected volumes for earthwork activities associated with the overall project and would not negatively change the risk profile of soil, sediment, water and waste aspects.

6.10.4 Mitigation/management

Mitigation and management measures for the approved project are relevant to the proposed modification. No additional mitigation measures are required.

The proposed modification would be managed in accordance with the:

- Approved *WBRP Construction Soil and Water Management Sub Plan* (Appendix B4 of the CEMP);
- Approved *WBRP Contaminated Land Management Plan* (Appendix B8 of the CEMP); and
- Approved *WBRP Construction Acid Sulfate Materials Management Plan* (Appendix B10 of the CEMP).

6.11 Hydrology

6.11.1 Introduction

Hydrology impacts were discussed in Section 7.7 and in *Working Paper 8 Hydrology* of the EIS.

6.11.2 Existing environment

The Hawkesbury River is part of the greater Hawkesbury-Nepean River, which is the largest river system in the Sydney region. Flooding of the Hawkesbury River at Windsor is influenced by flows from upstream tributaries (including upper catchment tributaries) as well as inflows from South Creek and constriction of flows through downstream gorges (located downstream of Wilberforce/Sackville).

The EIS presents the existing flooding conditions at Windsor and the flood affected properties for the 5 year Average Recurrence Interval (ARI), 20 year ARI, 100 year ARI and the probable maximum flood (PMF) flood events.

6.11.3 Impact assessment

The construction of the proposed modification would not significantly alter the impact of flooding on the project or the impacts of the project on flooding, compared to the current design and the potential impacts identified in the EIS.

During operation, the proposed modification would not significantly alter the flow distribution near Windsor, the peak water levels or property impacts compared to the current design and impacts identified in the EIS.

6.11.4 Mitigation/management

Mitigation and management measures for the approved project are relevant to the proposed modification. No additional mitigation measures are required.

6.12 Air quality

6.12.1 Introduction

Air quality impacts were discussed in Section 7.10 and in *Working Paper 11 Air Quality* of the EIS. The *WBRP Construction Air Quality Management Sub Plan* (Appendix B6 of the CEMP) was approved, as part of the CEMP, by DP&E 14 September 2018 and is currently implemented.

6.12.2 Existing environment

The EIS considered air quality at the project level based on the air quality monitoring station at Richmond located inside the campus of the University of Western Sydney, Hawkesbury. This data is considered representative of the location of the proposed modification.

6.12.3 Impact assessment

The proposed modification would not change air quality impacts during construction and operation of the project compared to the current design and impacts identified in the EIS.

Given the proposed modification would generate a similar amount of construction traffic, the air quality impacts of the proposed modification are consistent with the approved project.

During operation minor improvements to air quality may be achieved through less traffic congestion, particularly in the afternoon peak.

6.12.4 Mitigation/management

Mitigation and management measures for the approved project are relevant to the proposed modification. No additional mitigation measures are required.

The proposed modification would be managed in accordance with the *WBRP Construction Air Quality Management Sub Plan.*

7 Conditions of approval

7.1 Conditions to be amended or removed

A review of the MCoA for the project was undertaken to identify the conditions that would require either amendment or deletion as part of the proposed modification.

Only one condition would need to be changed as a result of the modification. Condition A1 would need to be updated to include this modification report and associated Response to Submissions Report. All other MCoA would continue to apply to the project.

Proposed amendments are shown in bold text and deletions shown as strikethrough text (e.g. ~~strikethrough~~ text).

Condition A1

The Applicant shall carry out the SSI generally in accordance with the:

a) State Significant Infrastructure Application SSI-4951;
b) Windsor Bridge Replacement Project Environmental Impact Statement Volumes 1, 2, 3 and 4 prepared by Sinclair Knight Merz for Roads and Maritime Services, dated November 2012;
c) Windsor Bridge Replacement Project Submissions Report incorporating Preferred Infrastructure Report, dated April 2013 prepared by Sinclair Knight Merz for Roads and Maritime Services, including the revised Statement of Commitments contained therein;
d) Any plans and/or documentation submitted to satisfy the Pre-Construction Conditions of this consent as approved in writing by the Director-General; ~~and~~
e) The conditions of this consent; **and**
f) Windsor Bridge Replacement Project Modification Environmental Assessment Modification, dated September 2019 prepared by Roads and Maritime, as amended by the Windsor Bridge Replacement Project Response to Submissions.

The proposed change would ensure that the MCoA are consistent with the proposed modification.

8 Environmental management measures

Mitigation and management measures identified in the EIS, SPIR, the Detailed Salvage Strategy and the Construction Environmental Management Plans (CEMPs) are considered sufficient to address the majority of impacts of the proposed modification. Additional mitigation measures are outlined in Table 8-1

Table 8-1: Additional mitigation measures

Aspect	Mitigation measure
Aboriginal heritage	To ensure the archaeological sensitivities are protected within the vicinity of SA 11, the following mitigation measures would be incorporated into the *WBRP Construction Heritage Management Sub Plan* (Appendix B5 of the CEMP) in order to increase this distance from construction areas of Aboriginal sensitivity: • The buffer zone would be reduced to 1m along its entire length (as marked in green on Figure 6-6b) and turned into a solid boundary through the use of temporary fencing to enforce a hard barrier which would not be crossed under any circumstances in order to increase the distance from construction areas to Aboriginal sensitivity; • With the exception of shallow excavation (<300mm) no direct impact would be permitted within the buffer zone; and • Indirect impacts must be appropriately managed (e.g. surface protection for heavy vehicles).
Planted Trees	• The batter located between the proposed road alignment and the *Araucaria cunninghamii* tree will be undertaken via one of the following methods, unless otherwise approved by Roads and Maritime: - Option 1: All proposed work is located at least three metres from the subject tree (measured from the edge of the trunk). This option would not require further root investigation or assessment by the project arborist; or - Option 2: The proposed work falls within three metres of the subject tree (measured from the edge of the trunk). This option would require further root investigation (by non-destructive methods) under supervision of the project arborist. Any proposed excavations that fall within 2.5 metres of the tree are not recommended and are likely to cause impacts that cannot be mitigated through the use of tree protection measures and/or tree sensitive construction techniques; and • Ensure the overhanging canopy of the *Araucaria cunninghamii* tree is protected and retained as its shape is important for its aesthetic appearance.
Visual amenity, urban design and landscape	• Additional tree planting along the parkland edge of Bridge Street should be considered, in consultation with Hawkesbury City Council, if additional visual separation is required between the parkland and the road.

9 Justification and conclusion

9.1 Need for modification

Roads and Maritime is replacing the existing bridge over the Hawkesbury River at Windsor. The project was approved by the former Minister for Planning and Infrastructure (SSI-4951) in December 2013. The approved project allows for construction and operation of a replacement bridge 35 metres downstream from the existing bridge, modifications to the existing intersections, new bridge approach roads to accommodate the new bridge location, and provision of a shared pedestrian and cycle pathway for access to and across the replacement bridge.

Since approval was granted for the WBRP, a construction contractor has been appointed to construct the approved project on behalf the proponent, Roads and Maritime. The Project is expected to be complete by early 2021.

As part of a regular process of review and as more than five years had passed since the traffic assessment was completed as part of the EIS, the Roads and Maritime undertook a new, independent traffic count and modelling report (Arcadis, 2018) for the project.

Roads and Maritime has undertaken additional investigations to confirm traffic growth rates since the EIS was prepared. Essentially the new study indicated that traffic had grown slightly faster than originally predicted, and that about 2,000 additional vehicles per day could potentially be travelling the route in 2026 than predicted in the EIS (2012).

This new study (Arcadis, 2018) reviewed current land use data, proposed future developments and reviewed traffic origins and destinations. The new traffic modelling with updated data, compared to the study undertaken in the EIS, indicated that the approved design would operate with a reduced level of service at the Bridge and George Street intersection than originally anticipated unless there is a better opportunity for vehicles to merge prior to approaching the new bridge.

With the approved design, the Bridge Street and George Street intersection would be at capacity during the afternoon peak within five years of the new bridge is opening. This would lead to traffic delays for northbound traffic, which would grow over time.

The proposed design modification would improve traffic flows in the long term and provide greater future proofing. Key benefits of the proposed modification, compared to the approved project, include:

- Improved northbound traffic flow through the Bridge Street and George Street intersection;
- Reduced delays in the afternoon peak including:
  - reduced delays at Bridge Street and George Street intersection,
  - reduced delays at Bridge Street and Macquarie Street intersection, and
- The design is expected to contribute to a lowering of the crash rate due to lesser congestion.

In the 2026 afternoon peak, the proposed modifications would improve the LoS at the Bridge Street and George Street intersection from LoS E with a delay of 62 seconds (approved design) to LoS B with a delay of 20 seconds (proposed modification design). At the Bridge Street and Macquarie Street intersection, the proposed modifications would improve intersection LoS from LoS E with a delay of 56 seconds (approved design) to LoS D with a delay of 48 seconds (proposed modification design). Additional information on the traffic benefits are provided in Section 0.

The proposed design change would have a relatively small impact on the overall construction cost and would have minimal additional community disruptions, if undertaken concurrently with building

the approved project. To defer the work would be more costly and prolong impacts to the community such as traffic delays and amenity impacts.

Based on the above, the proposed modification is considered to be justified and would represent an overall beneficial outcome for the approved project. The proposed changes would, whilst resulting in some impacts, result in the benefits listed above which would provide an improved outcome in comparison to the approved project for the local community.

9.2 Design options considered

Options were considered by Roads and Maritime when developing the proposed modification. As part of the options analysis, each option was reviewed against the project objectives.

The approved project has one dedicated northbound through lane at the Bridge and George Street intersection and across the bridge, and one dedicated northbound left hand turn lane into George Street. The new traffic study shows that during the afternoon peak there will likely be more congestion and delays at the Bridge and George Street intersection than originally anticipated unless there is a better opportunity for vehicles to merge prior to approaching the new bridge. This opportunity can be realised by either incorporating an additional lane on the bridge or by allowing two lanes of northbound traffic to move through the intersection and merge prior to reaching the bridge.

The option of adding an additional north-bound lane on the new bridge was considered but deemed to be unacceptable and unnecessary. Therefore, the options considered in detail were:

- Option 1 - the do nothing option and involves not undertaking the modification and retaining the current intersection design; and
- Option 2 - modifying the line marking to include two northbound through lanes at the approach of the Bridge Street and George Street intersection, and widening the northbound lane to include a new merge lane exiting the Bridge Street and George Street intersection.

Option 2 is the preferred option as it would represent an overall beneficial outcome for the approved project. The proposed changes would, whilst resulting in some impacts, result in the an improved outcome in comparison to the approved project for the local community.

9.3 Environmental assessment

Chapter 6 assessed the potential environmental impacts associated with the proposed modification and provides a comparison of the potential environmental impacts for the proposed modification and the approved project.

The proposed modification would result in the following:

- Traffic and transport:
  - improvement in the long term operational performance of project;
- Historic and maritime heritage:
  - location of the proposed modification is within an area suspected to contain historical archaeological deposits and relics. However, management of potential impacts, would be consistent with the Detailed Salvage Strategy (AAJV, 2017c) prepared under condition B3 of the project approval;
- Aboriginal heritage:

  - the proposed modification would bring construction works closer to the area of highly significant Aboriginal archaeology sensitivity. A reduction in the buffer zones identified in the Detailed Salvage Strategy (AAJV, 2017c) would mean additional Aboriginal archaeological impacts are not anticipated;
- Visual amenity, urban design and landscape:
  - the proposed modification would increase the width of Bridge Street by approximately three metres compared to the approved project. This would marginally increase the magnitude of the landscape character impact to Thompson Square, although the increase was not sufficient enough to increase the overall impact rating identified in the EIS;
  - the increased road width would be noticeable from two of the viewpoints identified in the EIS. However, the degree of change from the approved project would not be enough to change the overall visual impact rating identified in the EIS;
  - the proposed modification would encroach on an additional 160 square metres of the Thompson Square parkland. While the degree of change to the original project would be evident, it would not be enough to change the visual impact from that assessed in the EIS;
- Noise and vibration:
  - no change to the predicted total traffic noise level to residential receivers would result from to the proposed modification;
  - changes in noise levels within the recreational areas of Thompson Square would be minor; levels in the southern portion would increase due to the relocation of traffic lanes westward at the Bridge Street and George Street intersection, however levels would reduce in the north as the design increases separation distances to the design;
- Planted trees:
  - no additional trees would require removal as a result of the proposed modification compared to the approved project;
- Land use, property and socio-economic:
  - the proposed modification would bring construction works and operational traffic slightly closer to the recreational users of Thompson Square leading to slightly reduced amenity. However in the context of the project as a whole these impacts are not considered significant.
- Soil, sediments, water and waste:
  - the modification is generally consistent with the approved project with regards to soils, sediments, water and waste;
- Hydrology
  - The modification is generally consistent with the approved project with regards to hydrology; and
- Air quality:
  - The modification is generally consistent with the approved project with regards to air quality.

9.4 Environmental management measures and Conditions of Approval

Mitigation and management measures identified in the EIS, SPIR, the DSS and CEMP and associated sub-plans are considered sufficient to address the majority of impacts of the proposed modification. Additional mitigation measures to address the potential impacts to Aboriginal

heritage, the *Araucaria cunninghamii* tree and visual amenity have been included to reduce the potential impacts of the proposed modification.

9.5 Community and stakeholder consultation

This modification report will be exhibited for to enable the community and other stakeholders to provide comment on the proposal. In addition community updates will be issued explaining the modification and providing information on its public exhibition.

Following exhibition of the modification report, Roads and Maritime will review the submissions received and respond to the issues raised in a Response to Submissions Report.

10 References

AAJV, 2016a. *Historical and Maritime Archaeological Research Design,* s.l.: Prepared by AAJV (an Austral & Extent Joint Venture) on behalf of NSW Roads and Maritime Services, 4 October 2016.

AAJV, 2016b. *Aboriginal Archaeological Research Design and Excavation Methodology,* s.l.: Prepared by AAJV (an Austral & Extent Joint Venture) on behalf of NSW Roads and Maritime Services, 5 July 2016.

AAJV, 2016c. *Hawkesbury Region Sand Body Study - Research Design,* s.l.: Prepared by AAJV (an Austral & Extent Joint Venture) on behalf of NSW Roads and Maritime Services, 16 June 2016.

AAJV, 2017a. *Test Excavation Report – Historical Archaeology,* s.l.: Prepared by AAJV (an Austral & Extent Joint Venture) on behalf of NSW Roads and Maritime Services, 24 May 2017.

AAJV, 2017b. *Test Excavation Report – Aboriginal Heritage,* s.l.: Prepared by AAJV (an Austral & Extent Joint Venture) on behalf of NSW Roads and Maritime Services, 23 May 2017.

AAJV, 2017c. *Detailed Salvage Strategy for Aboriginal and Historical Archaeological Heritage,* s.l.: Prepared by AAJV (an Austral & Extent Joint Venture) on behalf of NSW Roads and Maritime Services, 17 August 2017.

AAJV, 2017d. *Hawkesbury Region Sand Bodies Study,* s.l.: Prepared by AAJV (an Austral & Extent Joint Venture) on behalf of NSW Roads and Maritime Services, 31 October 2017.

AAJV, 2018a. *Thompson Square Brick Drain, Windsor, NSW. Heritage Mitigation and Options Report,* s.l.: Prepared by AAJV (an Austral & Extent Joint Venture) on behalf of NSW Roads and Maritime Services, 23 May 2018..

AAJV, 2018b. *Salvage Excavation Report – Aboriginal Heritage. In draft,* s.l.: Prepared by AAJV (an Austral & Extent Joint Venture) on behalf of NSW Roads and Maritime Services.

AAJV, 2018c. *Strategic Conservation Management Plan. Thompson Square and Windsor Bridge Replacement Program Project Area,* s.l.: Volumes 1-4. Preapred by AAJV (Austral AHMS Joint Venture) on behalf of NSW Roads and Maritime.

Arcadis, 2018. *Windsor Bridge Replacement Project. Traffic and Options Modelling Report,* s.l.: Prepared by Arcadis on behalf of Roads and Maritime Services.

Bannerman, S. M. & Hazelton, P. A., 1990. *Soil Landscapes of the Penrith 1:100 000,* s.l.: s.n.

Cosmos Archaeology, 2018. *Maritime Archaeological Testing Report and Detailed Salvage Strategy for Maritime Archaeological Excavation,* s.l.: Prepared by Cosmos Archaeology Pty Ltd on behalf of NSW Roads and Maritime Services, March 2018.

Roads and Maritime, 2018a. *Windsor Bridge Replacment Project. Community Communication Strategy,* s.l.: Prepared by NSW Roads and Maritime Services, September 2018.

Roads and Maritime, 2018b. *Appendix B8 Construction Contaminated Land Management Plan. Windsor Bridge Replacement Project,* s.l.: NSW Roads and Maritime Services. September 2018.

SKM, 2012. *Windsor Bridge Replacement Project Environmental Impact Statement,* s.l.: Prepared by Sinclair Knight Mertz (SKM) for Roads and Maritime Services, November 2012.

SKM, 2013. *Windsor Bridge Replacement Project Submissions report incorporating preferred infrastructure report,* s.l.: Prepared by Sinclair Knight Mertz for Roads and Maritime Services, April 2013.

Tree Survey, 2019. *Arboricultural Impact Assessment. Windosr Bridge Replacement Project. ,* s.l.: Prepared for Cardno on behalf of Roads and Maritime Services.

Terms and acronyms used in this report

Term / Acronym	Description
AAJV	Austral & Extent Joint Venture
AFG	Aboriginal Focus Group
AIA	Arboricultural Impact Assessment
CEMP	Construction Environmental Management Plan
CoRTN	Calculation of road Traffic Noise
CSS	Community Consultation Strategy
DBH	breast height
DGRs	Director General's requirements
DP&E	former NSW Department of Planning and Environment, now Department of Planning, Industry and Environment (DPI&E) – Planning and Assessment
DPI	Department of Primary Industries
DPI&E	Department of Planning, Industry and Environment
DSS	Detailed Salvage Strategy
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW). Provides the legislative framework for land use planning and development assessment in NSW
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.
LCZ	Landscape Character Zones
LGA	Local Government Area
LoS	Level of Service – An index of the operational performance of traffic on a given traffic lane, carriageway or road when accommodating carious traffic volumes under difference combinations of operating conditions
MCoA	Minister's Conditions of Approval
NES	Matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

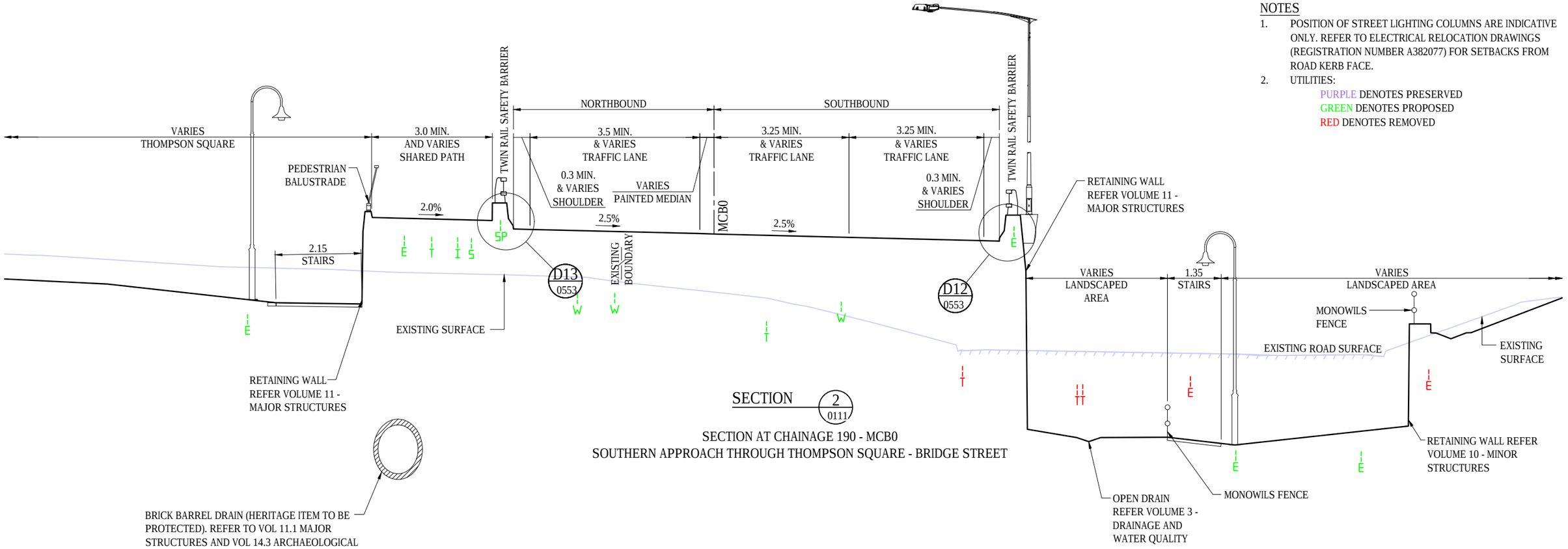
Term / Acronym	Description
OEH	former Office of Environment and Heritage, now Department of Premier and Cabinet (DPC)
Open space	Space available for recreational uses.
Roads and Maritime	NSW Roads and Maritime Services
SCMP	Strategic Conservation Management Plan
SHR	State Heritage Register
SMM	Spackman Mossop Michaels
SPIR	Submissions Report incorporating Preferred Infrastructure Report
SRZ	structural root zone
SSI	State Significant Infrastructure
the Project	The Windsor Bridge Replacement Project
TEC	threatened ecological communities
TPZ	tree protection zone
TSCA	Thompson Square Conservation Area. Also known as the Thompson Square Precinct, this is the area of Thompson Square listed on the State Heritage Register of NSW. One of the oldest public squares in Australia, constructed in 1811. Surrounding buildings were constructed between 1815 and 1880 in the colonial Georgian style. The Square consists of George Street, Bridge Street, Thompson Square and The Terrace.
Thompson Square open space area	Including all public lands (roads, footpaths, car parks, parkland areas, verges and medians) within Thompson Square.
Thompson Square lower parkland	Includes the parkland area below / north of Bridge Street bounded by Bridge Street, Old Bridge Street and The Terrace.
Thompson Square parkland	The parkland area bounded by George Street, Old Bridge Street, The Terrace and Thompson Square road. It includes both the Thompson Square upper and lower parkland areas.
Thompson Square road	The road on the western side of Thompson Square parkland.
Thompson Square upper parkland	Includes the parkland area above / south of Bridge Street bounded by Bridge Street, George Street and Thompson Square road.
UDLP	Urban Design and Landscape Plan
VEM	Visual Envelope Map
WBRP	Windsor Bridge Replacement Project

Term / Acronym	Description
Zip merge lane	A zip merge lane is where the white line marking ends before the lanes merge. The car behind gives way to the car in front. This reduces congestion by allowing motorists to stay in their lanes right up until the merge point.

Appendix A – Design Drawings

NOTES

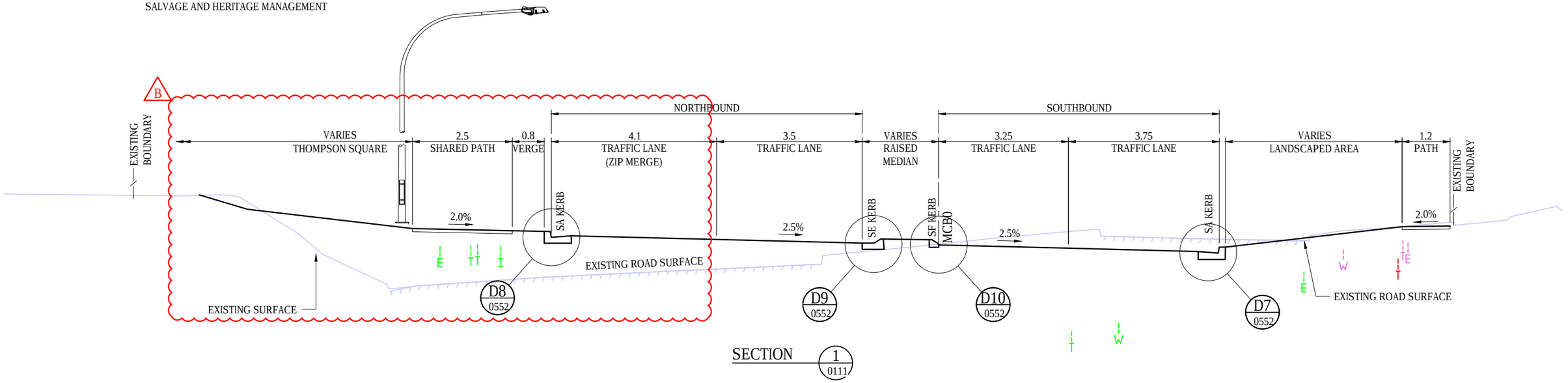
1. POSITION OF STREET LIGHTING COLUMNS ARE INDICATIVE ONLY. REFER TO ELECTRICAL RELOCATION DRAWINGS (REGISTRATION NUMBER A382077) FOR SETBACKS FROM ROAD KERB FACE.
2. UTILITIES:
   - PURPLE DENOTES PRESERVED
   - GREEN DENOTES PROPOSED
   - RED DENOTES REMOVED



SECTION 2 / 0111

SECTION AT CHAINAGE 190 - MCB0
SOUTHERN APPROACH THROUGH THOMPSON SQUARE - BRIDGE STREET

BRICK BARREL DRAIN (HERITAGE ITEM TO BE PROTECTED). REFER TO VOL 11.1 MAJOR STRUCTURES AND VOL 14.3 ARCHAEOLOGICAL SALVAGE AND HERITAGE MANAGEMENT



SECTION 1 / 0111

SECTION AT CHAINAGE 140 - MCB0
SOUTHERN APPROACH THROUGH THOMPSON SQUARE - BRIDGE STREET

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
B	06.09.19	MERGE DESIGN INCLUSION (INFORMATION ISSUE)	SH	BDP	TR
A	14.05.18	ACCEPTED FOR CONSTRUCTION	SH	BDP	TR

TITLE	INITIAL	DATE
DRAFTSPERSON	JP	14.05.18
DRAFTING CHECK	SH	14.05.18
DESIGNER	DH	14.05.18
DESIGN CHECK	BDP	14.05.18
PROJECT MANAGER	TR	14.05.18

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:100 1 0 1 2 AT A3
CO-ORDINATE SYSTEM: MGA Zone 56
HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
JACOBS
177 Pacific Highway
North Sydney, SYDNEY, NSW 2060
AUSTRALIA
Tel: (02) 9928 2100 Fax (02) 9928 2500
Web: www.jacobs.com

CLIENT
NSW GOVERNMENT Transport Roads & Maritime Services
PREPARED FOR
GREATER SYDNEY PROJECT OFFICE
SYDNEY OUTER

PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
GENERAL
TYPICAL CROSS SECTIONS
SHEET 1

STATUS
FOR INFORMATION

VOLUME	RMS REGISTRATION No	
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PHASE	DRAWING No	REV
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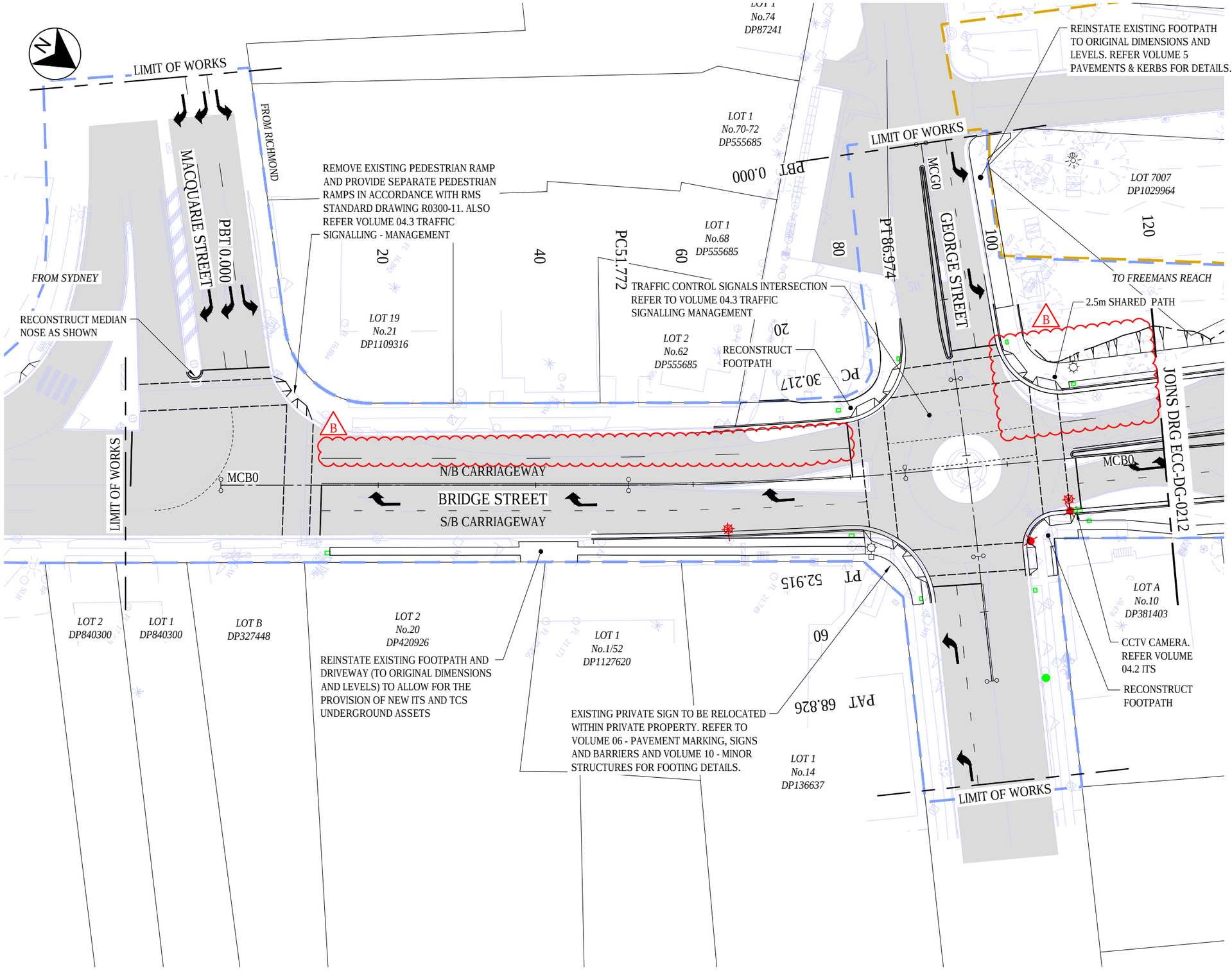
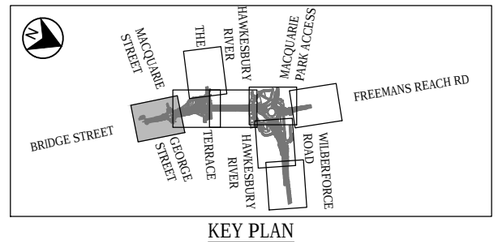


LEGEND

- EXISTING PAVEMENT
- EXISTING PROPERTY BOUNDARY
- EXISTING EASEMENT BOUNDARY (REFER NOTE 1)
- Mxxx 100 — MAIN ALIGNMENT AND LOCAL ROADS CONTROL LINE, LABEL AND STATION
- PEDESTRIAN SAFETY FENCE (REFER DRAWING VOLUME 06 - PAVEMENT MARKING, SIGNS AND BARRIERS)
- CB — TWIN RAIL BARRIER (REFER DRAWING VOLUME 11 - MAJOR STRUCTURES)
- CONSTRUCTION WORK ZONE
- WORKS SUBJECT TO FURTHER COUNCIL AND STAKEHOLDER CONSULTATION
- RETAINING WALL
- PROPERTY ADJUSTMENT
- STREET LIGHTING
- PROPOSED ELECTRICAL POLE AND GROUND STAY
- POWER POLE/ STREET LIGHT TO BE REMOVED

NOTES

1. FOR EASEMENTS AND PROPERTY ADJUSTMENT WORKS REFER TO VOLUME 07 - PROPERTY WORKS.



KEY PLAN

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
B	06.09.19	MERGE DESIGN INCLUSION (INFORMATION ISSUE)	SH	BDP	TR
A	14.05.18	ACCEPTED FOR CONSTRUCTION	SH	BDP	TR

TITLE	INITIAL	DATE
DRAFTSPERSON	JP	14.05.18
DRAFTING CHECK	SH	14.05.18
DESIGNER	DH	14.05.18
DESIGN CHECK	BDP	14.05.18
PROJECT MANAGER	TR	14.05.18

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:500 5 0 5 10 AT A3
CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
JACOBS
177 Pacific Highway
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CLIENT
NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR
GREATER SYDNEY PROJECT OFFICE
SYDNEY OUTER

PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
ROADWORKS
PLAN
SHEET 1

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING
DS2012-000289-DES-WINDSOR-190906

STATUS
FOR INFORMATION

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PHASE	DRAWING No	REV
INFO	NB98005-ECC-DG-0211	B

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ACCESS STAIRS. REFER VOLUME 10 - MINOR STRUCTURES

No.81 | No.7 | LOT 1 No.5 DP745036 | LOT 1 No.3 DP196531 | LOT B No.1 DP161643

FOR EARTHWORKS IN THOMPSON SQUARE REFER TO GRADING PLANS DG-0252

JOINS DRG ECC-DG-0218

VIEWING PLATFORM REFER TO VOLUME 10 - MINOR STRUCTURES

THOMPSON SQUARE

EXISTING COUNCIL STAIRS TO BE REMOVED

FOR SCOUR PROTECTION WORKS REFER TO VOLUME 09

FROM SYDNEY

TO FREEMANS REACH

LOT 7007 DP1029964

PC145.309

PT 214.020

THE TERRACE

WESTERN RETAINING WALL. REFER VOLUME 11 - MAJOR STRUCTURES

DRAINAGE SWALE

REFER INSET 'A' FOR DESIGN ALONG THE TERRACE UNDER BRIDGE

1.5m FOOTPATH

ACCESS STAIRS. REFER VOLUME 10 - MINOR STRUCTURES

BRIDGE ABUTMENT 'A'

2.5m SHARED PATH

BRIDGE STREET

N/B CARRIAGEWAY

S/B CARRIAGEWAY

JOINS DRG ECC-DG-0211

JOINS DRG ECC-DG-0213

MCB0

MCT0

MCT1

MKT2

PBT 0.000

PAT 27.000

PAT 122.002

PAT 28.912

DRIVEWAY CROSSING

1.2m (MIN) FOOTPATH

EASTERN RETAINING WALL. REFER VOLUME 11 - MAJOR STRUCTURES

CARPARK RETAINING WALL. REFER VOLUME 11 - MAJOR STRUCTURES

EXISTING PROPERTY No.4 ACCESS TO REMAIN (LEFT IN / LEFT OUT)

EXISTING PROPERTY No.6 ACCESS TO REMAIN (LEFT IN / LEFT OUT)

LOT A No.10 DP381403

LOT 1 No.6 DP995391

LOT 10 No.4 DP666894

MATCH EXISTING FOOTPATH

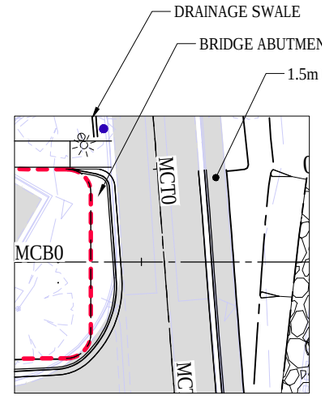
WINDSOR WHARF

LIMIT OF WORKS

COUNCIL CARPARK

LEGEND

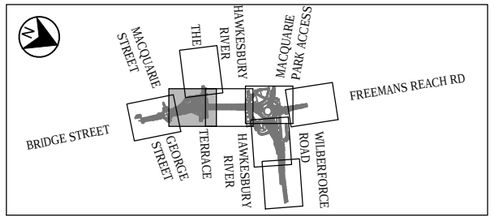
- EXISTING PAVEMENT
- EXISTING PROPERTY BOUNDARY
- EXISTING EASEMENT BOUNDARY (REFER NOTE 1)
- Mxxx 100 — MAIN ALIGNMENT AND LOCAL ROADS CONTROL LINE, LABEL AND STATION
- PEDESTRIAN SAFETY FENCE (REFER DRAWING VOLUME 06 - PAVEMENT MARKING, SIGNS AND BARRIERS)
- CB — TWIN RAIL BARRIER (REFER DRAWING VOLUME 11 - MAJOR STRUCTURES)
- CONSTRUCTION WORK ZONE
- WORKS SUBJECT TO FURTHER COUNCIL AND STAKEHOLDER CONSULTATION
- RETAINING WALL
- PROPERTY ADJUSTMENT
- STREET LIGHTING
- PROPOSED ELECTRICAL POLE AND GROUND STAY
- POWER POLE/ STREET LIGHT TO BE REMOVED



INSET 'A'
DESIGN ALONG THE TERRACE UNDER BRIDGE

NOTES

1. FOR EASEMENTS AND PROPERTY ADJUSTMENT WORKS REFER TO VOLUME 07 - PROPERTY WORKS.



KEY PLAN

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
B	06.09.19	MERGE DESIGN INCLUSION (INFORMATION ISSUE)	SH	BDP	TR
A	14.05.18	ACCEPTED FOR CONSTRUCTION	SH	BDP	TR

TITLE	INITIAL	DATE
DRAFTSPERSON	JP	14.05.18
DRAFTING CHECK	SH	14.05.18
DESIGNER	DH	14.05.18
DESIGN CHECK	BDP	14.05.18
PROJECT MANAGER	TR	14.05.18

ORIGINAL DRAWING AT A3 SIZE

SCALE 1:500 5 0 5 10 AT A3

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
JACOBS
177 Pacific Highway
North Sydney, SYDNEY, NSW 2060
AUSTRALIA
Tel: (02) 9928 2100 Fax (02) 9928 2500
Web: www.jacobs.com

CLIENT
NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR
GREATER SYDNEY PROJECT OFFICE
SYDNEY OUTER

PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
ROADWORKS
PLAN
SHEET 2

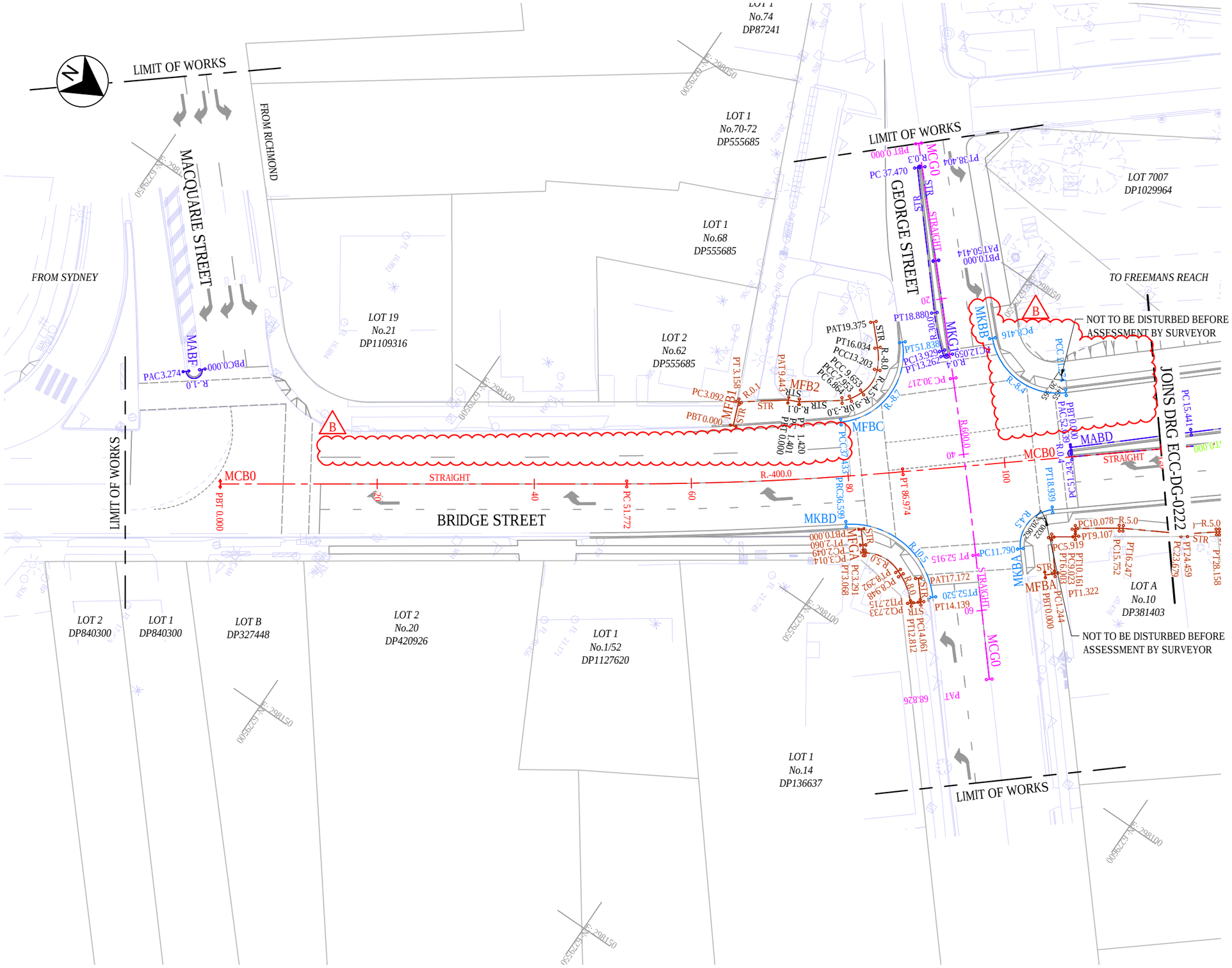
DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING
DS2012-000289-DES-WINDSOR-190906

STATUS
FOR INFORMATION

VOLUME	RMS REGISTRATION No	
02	DS2012/000289	
PHASE	DRAWING No	REV
INFO	NB98005-ECC-DG-0212	B

DATE: 4/09/2019 9:45:11 AM LOGIN NAME: HAIL, SCOTT
LOCATION: C:\Users\shail\AppData\Local\Projectwise\ms_projects\dms00629\NB98005-ECC-DG-0211-0218.dwg

0 | 5 | 10 | 15 | 20 | 25 mm ON A3 ORIGINAL

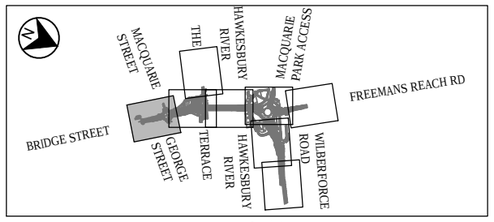


LEGEND

- Mxxx — MAIN ROAD ALIGNMENT SETOUT CONTROL
- Mxxx — LOCAL ROAD ALIGNMENT SETOUT CONTROL
- Mxxx — PROPERTY ACCESS ALIGNMENT SETOUT CONTROL
- Mxxx — KERB RETURN SETOUT CONTROL
- Mxxx — MEDIAN SETOUT CONTROL
- Mxxx — PATH SETOUT CONTROL
- Mxxx — BARRIER SETOUT CONTROL
- Mxxx — EARTHWORKS SETOUT CONTROL
- PR07 / 7.974 — SURVEY CONTROL POINT, REDUCED LEVEL AND STATION I.D
- E: 298050 / N: 6280050 — PROJECT GRID MGA ZONE 56, EASTING: NORTHING:

NOTES

1. FOR SURVEY CONTROL MARK LOCATION DATA REFER DRAWING NB98005-ECC-DG-0231.
2. FOR ALIGNMENT SETOUT CONTROL SCHEDULES REFER DRAWING NB98005-ECC-DG-0232-0235.
3. FOR LONGITUDINAL SECTIONS OF ALIGNMENTS REFER DRAWINGS NB98005-ECC-DG-0241-0250 & PROFILES NB98005-ECC-DG-0261-0280.
4. THE CARE, PRESERVATION AND PROTECTION OF SURVEY CONTROL MARKS SHALL BE IN ACCORDANCE WITH RMS G71 SPECIFICATION.



KEY PLAN

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PROJECT MANAGER	TR	14.05.18

ORIGINAL DRAWING AT A3 SIZE — SCALE 1:500 — 5 0 5 10 — AT A3

CO-ORDINATE SYSTEM: MGA Zone 56 — HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY

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177 Pacific Highway
North Sydney, SYDNEY, NSW 2060
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CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR: GREATER SYDNEY PROJECT OFFICE SYDNEY OUTER

PROJECT: HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
ROADWORKS
ALIGNMENT AND SETOUT CONTROL PLAN
SHEET 1

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING: DS2012-000289-DES-WINDSOR-190906

STATUS: **FOR INFORMATION**

VOLUME: 02 — RMS REGISTRATION No: DS2012/000289

PHASE: INFO — DRAWING No: NB98005-ECC-DG-0221 — REV: B

DATE: 4/09/2019 9:45:14 AM LOGIN NAME: HAIL, SCOTT
LOCATION: C:\Users\shail\AppData\Local\Bentley\Projectwise\ims_projects\dms00629\NB98005-ECC-DG-0221-0228.dwg

0 | 5 | 10 | 15 | 20 | 25 mm ON A3 ORIGINAL

No.81

No.7

LOT 1
No.5
DP745036

LOT 1
No.3
DP196531

LOT B
No.1
DP161643

NOTE:
ALIGNMENTS ASSOCIATED WITH STAIRS AND MINOR RETAINING STRUCTURES. REFER VOLUME 10 MINOR STRUCTURES FOR ADDITIONAL DETAILS.

JOINS DRG ECC-DG-0228

THOMPSON SQUARE

THE TERRACE

JOINS DRG ECC-DG-0223

JOINS DRG ECC-DG-0221

BRIDGE STREET

NOT TO BE DISTURBED BEFORE ASSESSMENT BY SURVEYOR

FROM SYDNEY

TO FREEMANS REACH

LOT 7007
DP1029964

LOT A
No.10
DP381403

LOT 1
No.6
DP995391

LOT 10
No.4
DP666894

NOTE:
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LIMIT OF WORKS

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- Mxxx — BARRIER SETOUT CONTROL
- Mxxx — EARTHWORKS SETOUT CONTROL
- PR07 7.974 — SURVEY CONTROL POINT, REDUCED LEVEL AND STATION I.D
- PROJECT GRID MGA ZONE 56, EASTING: NORTHING:

NOTES

1. FOR SURVEY CONTROL MARK LOCATION DATA REFER DRAWING NB98005-ECC-DG-0231.
2. FOR ALIGNMENT SETOUT CONTROL SCHEDULES REFER DRAWING NB98005-ECC-DG-0232-0235.
3. FOR LONGITUDINAL SECTIONS OF ALIGNMENTS REFER DRAWINGS NB98005-ECC-DG-0241-0250 & PROFILES NB98005-ECC-DG-0261-0280.
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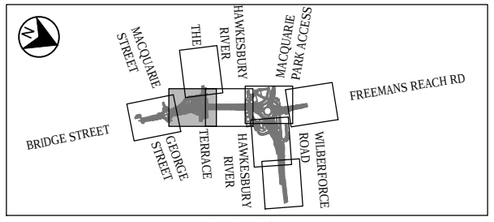
KEY PLAN



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DESIGN CHECK	BDP	14.05.18
PROJECT MANAGER	TR	14.05.18

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:500 (5 0 5 10) AT A3
CO-ORDINATE SYSTEM: MGA Zone 56
HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
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SYDNEY OUTER

PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
ROADWORKS
ALIGNMENT AND SETOUT CONTROL PLAN
SHEET 2

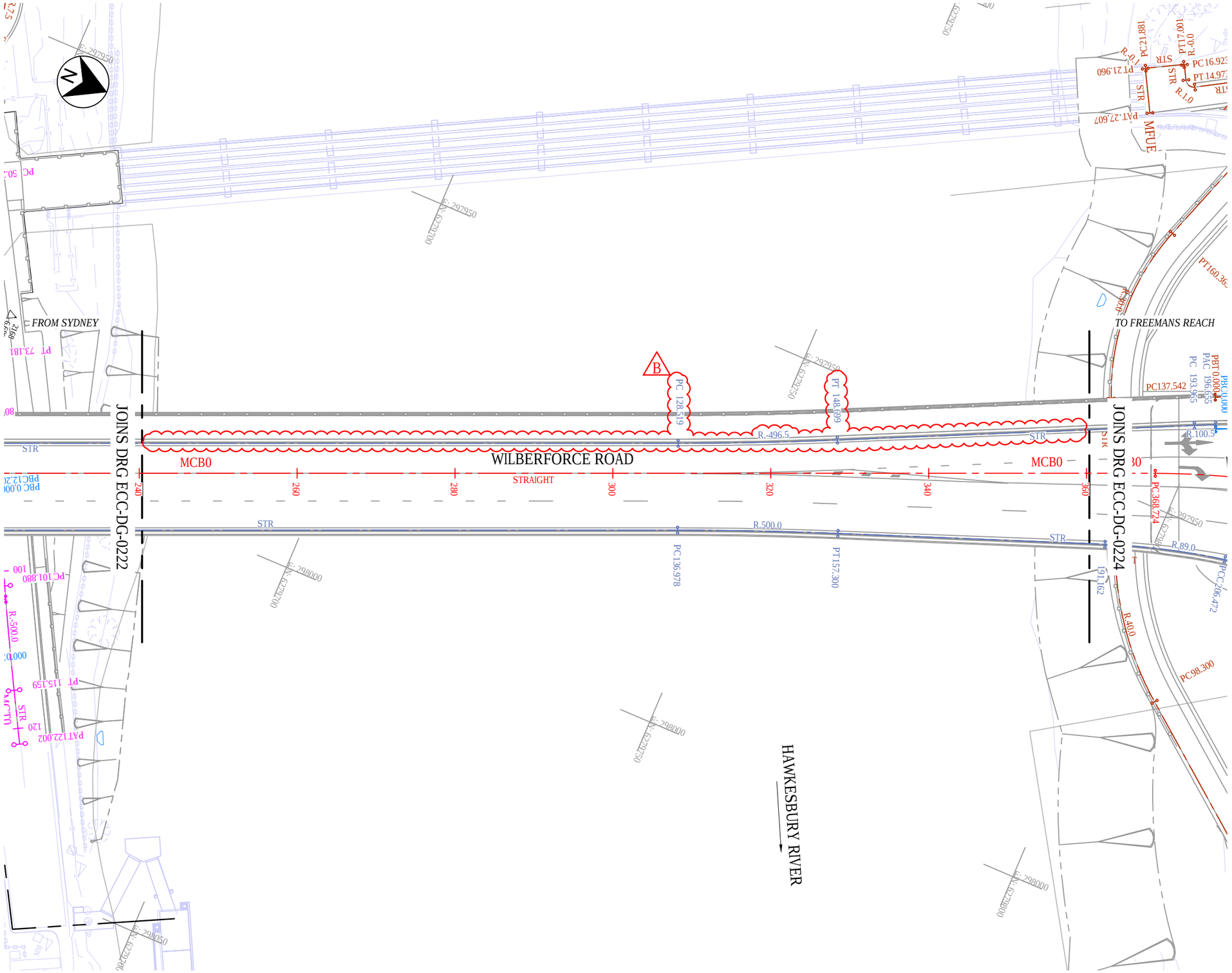
DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING
DS2012-000289-DES-WINDSOR-190906

STATUS
FOR INFORMATION

VOLUME 02
RMS REGISTRATION No DS2012/000289
PHASE INFO
DRAWING No NB98005-ECC-DG-0222
REV B

DATE: 4/09/2019 9:45:17 AM LOGIN NAME: HAIL, SCOTT
LOCATION: C:\Users\shail\AppData\Local\Projectwise\ms_projects\dms00629\NB98005-ECC-DG-0221-0228.dwg

0 5 10 15 20 25 mm ON A3 ORIGINAL



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- Mxxx — BARRIER SETOUT CONTROL
- Mxxx — EARTHWORKS SETOUT CONTROL
- SURVEY CONTROL POINT
  REDUCED LEVEL
  AND STATION I.D

PR07
7.974

PROJECT GRID MGA ZONE 56
EASTING: NORTHING:

NOTES

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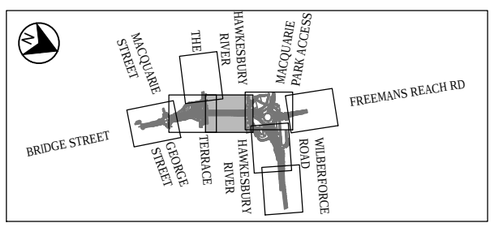

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PROJECT MANAGER	TR	14.05.18

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:500 (5 0 5 10)
AT A3

CO-ORDINATE SYSTEM: MGA Zone 56
HEIGHT DATUM: A.H.D.

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MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
ROADWORKS
ALIGNMENT AND SETOUT CONTROL PLAN
SHEET 3

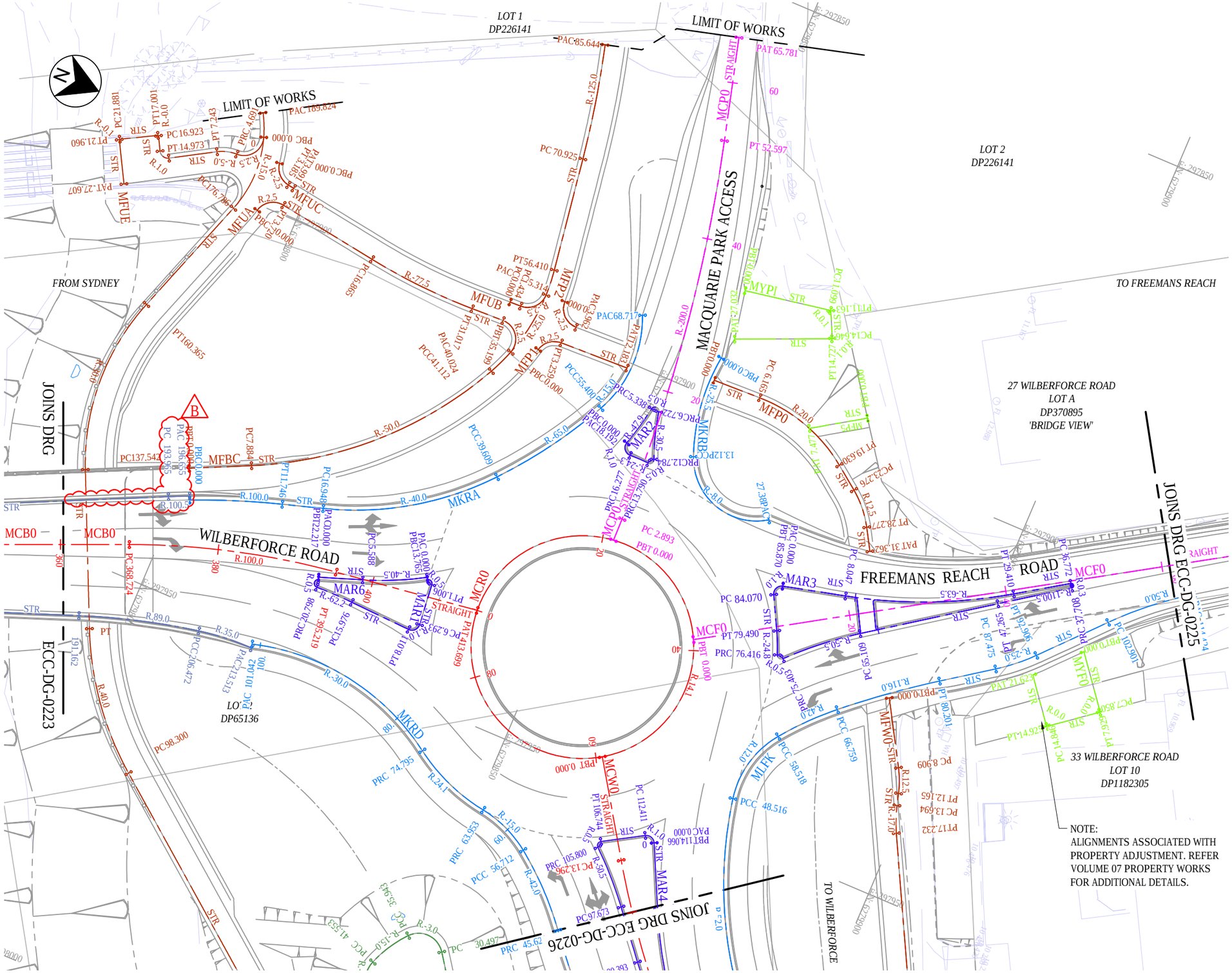
DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING
DS2012-000289-DES-WINDSOR-190906

STATUS
FOR INFORMATION

VOLUME	RMS REGISTRATION No	
02	DS2012/000289	
PHASE	DRAWING No	REV
INFO	NB98005-ECC-DG-0223	B

DATE: 4/09/2019 9:45:19 AM LOGIN NAME: HAIL, SCOTT
LOCATION: C:\Users\shail\AppData\Local\Bentley\Projectwise\ms_projects\dms00629\NB98005-ECC-DG-0221-0228.dwg

0 5 10 15 20 25 mm ON A3 ORIGINAL



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- SURVEY CONTROL POINT
- REDUCED LEVEL
- AND STATION I.D
- PROJECT GRID MGA ZONE 56
- EASTING: NORTHING:

NOTES

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2. FOR ALIGNMENT SETOUT CONTROL SCHEDULES REFER DRAWING NB98005-ECC-DG-0232-0235.
3. FOR LONGITUDINAL SECTIONS OF ALIGNMENTS REFER DRAWINGS NB98005-ECC-DG-0241-0250 & PROFILES NB98005-ECC-DG-0261-0280.
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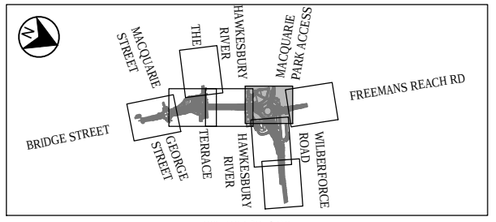
NOTE:
ALIGNMENTS ASSOCIATED WITH PROPERTY ADJUSTMENT. REFER VOLUME 07 PROPERTY WORKS FOR ADDITIONAL DETAILS.



KEY PLAN

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DESIGNER	DH	14.05.18
DESIGN CHECK	BDP	14.05.18
PROJECT MANAGER	TR	14.05.18

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:500 (5 0 5 10) AT A3
CO-ORDINATE SYSTEM: MGA Zone 56
HEIGHT DATUM: A.H.D.

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ROADWORKS
ALIGNMENT AND SETOUT CONTROL PLAN
SHEET 4

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING
DS2012-000289-DES-WINDSOR-190906

STATUS
FOR INFORMATION

VOLUME 02
RMS REGISTRATION No DS2012/000289
PHASE INFO
DRAWING No NB98005-ECC-DG-0224
REV B

DATE: 4/09/2019 9:45:22 AM LOGIN NAME: HAIL, SCOTT
LOCATION: C:\Users\shail\AppData\Local\Temp\projectwise\mms_projects\dms00629\NB98005-ECC-DG-0221-0228.dwg

0 5 10 15 20 25 mm ON A3 ORIGINAL

ALIGNMENT SETOUT CONTROL - MAIN ROAD

COD	STATION	EASTING	NORTHING	BEARING	RADIUS
MCB0					
PB	0.000	298129.501	6279479.841	325°35'34.38"	STRAIGHT
PC	51.772	298100.246	6279522.556	325°35'34.38"	-400.000
PT	86.974	298079.103	6279550.686	320°33'02.33"	STRAIGHT
PC	145.309	298042.038	6279595.731	320°33'02.33"	240.000
PT	214.020	298006.516	6279654.275	336°57'15.37"	STRAIGHT
PC	368.724	297945.955	6279796.633	336°57'15.37"	100.000
PT	395.219	297938.915	6279822.095	352°08'04.70"	STRAIGHT
PA	413.699	297936.386	6279840.401	352°08'04.70"	STRAIGHT
MCW0					
PB	0.000	297947.240	6279862.234	56°35'43.50"	STRAIGHT
PC	13.296	297958.340	6279869.554	56°35'43.50"	-118.500
PT	46.989	297983.470	6279891.827	40°18'14.88"	STRAIGHT
PC	61.274	297992.710	6279902.720	40°18'14.88"	180.000
PT	132.140	298047.877	6279946.472	62°51'42.16"	STRAIGHT
PC	230.080	298135.034	6279991.146	62°51'42.16"	-580.000
PA	290.704	298187.441	6280021.567	56°33'40.90"	-580.000
MCR0					
PB	0.000	297936.386	6279840.401	266°11'58.21"	14.100
PA	88.492	297936.486	6279840.408	265°47'31.75"	14.100

ALIGNMENT SETOUT CONTROL - LOCAL ROADS

COD	STATION	EASTING	NORTHING	BEARING	RADIUS
MCP0					
PB	0.000	297921.469	6279852.800	269°13'00.68"	STRAIGHT
PC	2.893	297918.576	6279852.761	269°13'00.68"	-200.000
PT	52.597	297869.471	6279845.944	254°58'39.96"	STRAIGHT
PA	65.781	297856.738	6279842.527	254°58'39.96"	STRAIGHT
MCF0					
PB	0.000	297929.069	6279867.035	328°08'03.30"	STRAIGHT
PA	115.000	297868.357	6279964.703	328°08'03.30"	STRAIGHT
MCT0					
PB	0	297927.23	6279618.38	58°40'17.46"	STRAIGHT
PC	3.325	297930.07	6279620.11	58°40'17.46"	100.000
PT	4.286	297930.89	6279620.6	59°13'19.40"	STRAIGHT
PC	24.353	297948.13	6279630.87	59°13'19.40"	100.000
PT	25.65	297949.25	6279631.53	59°57'54.75"	STRAIGHT
PC	50.293	297970.59	6279643.86	59°57'54.75"	500.000
PT	73.181	297990.66	6279654.86	62°35'16.57"	STRAIGHT
PC	101.88	298016.13	6279668.07	62°35'16.57"	-500.000
PT	115.159	298027.84	6279674.34	61°03'58.45"	STRAIGHT
PA	122.002	298033.83	6279677.65	61°03'58.45"	STRAIGHT
MCG0					
PB	0.000	298043.477	6279528.731	47°13'28.08"	STRAIGHT
PC	30.217	298065.657	6279549.252	47°13'28.08"	600.000
PT	52.915	298082.605	6279564.348	49°23'31.04"	STRAIGHT
PA	68.826	298094.685	6279574.705	49°23'31.04"	STRAIGHT
MCY1					
PB	0.000	298017.628	6279668.851	154°04'38.49"	STRAIGHT
PA	27.000	298029.431	6279644.567	154°04'38.49"	STRAIGHT
MKT2					
PB	0.000	298022.902	6279657.999	65°53'13.04"	STRAIGHT
PA	28.884	298049.266	6279669.799	65°53'13.04"	STRAIGHT

ALIGNMENT SETOUT CONTROL - KERBS

COD	STATION	EASTING	NORTHING	BEARING	RADIUS
MKBA					
PC	11.790	298078.726	6279568.582	229°32'02.23"	4.500
PT	18.939	298072.331	6279569.146	320°33'02.34"	4.500
MKBB					
PC	8.416	298058.620	6279550.504	455054.044	-8.424
PCC	21.274	298059.051	6279562.142	3182401.461	STRAIGHT
MKBC					
PCC	37.433	298078.336	6279540.601	320°23'58.27"	-8.750
PT	51.838	298065.524	6279541.326	226°04'30.20"	STRAIGHT
MKBD					
PRC	36.599	298088.713	6279548.490	322°06'55.02"	10.500
PT	52.520	298090.110	6279562.861	48°59'28.72"	10.500
MKT5					
PB	0.000	298025.752	6279669.178	241°21'51.42"	-8.500
PCC	8.784	298021.332	6279662.038	182°09'13.49"	-3.000
PA	14.872	298025.555	6279659.187	65°53'13.08"	-3.000
MKT6					
PB	0.000	298005.976	6279658.807	62°35'26.34"	8.500
PCC	7.646	298013.364	6279659.018	114°07'55.79"	4.000
PT	10.435	298015.326	6279657.117	154°04'36.05"	STRAIGHT
PC	27.894	298022.958	6279641.414	154°04'36.05"	-0.100
PT	28.051	298023.092	6279641.368	64°04'36.05"	STRAIGHT
PC	35.051	298029.388	6279644.428	64°04'36.05"	-0.100
PT	35.208	298029.434	6279644.562	334°04'36.06"	STRAIGHT
PC	39.588	298027.519	6279648.501	334°04'36.06"	1.300
PT	41.189	298027.764	6279649.983	44°39'26.66"	STRAIGHT
PC	51.969	298035.340	6279657.651	44°39'26.66"	5.000
PT	53.822	298036.854	6279658.700	65°53'11.15"	STRAIGHT
PA	69.687	298051.335	6279665.182	65°53'11.15"	STRAIGHT
MKTN					
PB	0.000	297999.612	6279651.153	336°57'15.37"	STRAIGHT
PC	2.487	297998.639	6279653.441	336°57'15.37"	1.500
PT	4.729	297999.329	6279655.360	62°35'26.32"	STRAIGHT
PA	12.202	298005.963	6279658.800	62°35'26.32"	STRAIGHT
MKRB					
PB	0.000	297894.908	6279856.331	97°26'18.44"	-25.500
PCC	13.125	297907.784	6279857.982	67°56'49.47"	-8.000
PA	27.382	297911.400	6279869.889	325°50'28.16"	-8.000

B

LEGEND

HORIZONTAL CODES (COD)

PB	POINT BEFORE (START)
PC	POINT OF CURVATURE
PT	POINT OF TANGENCY
PCC	POINT OF COMMON CURVATURE
PRC	POINT OF REVERSE CURVATURE
PA	POINT AFTER (END)

ALIGNMENT SETOUT CONTROL - KERBS

COD	STATION	EASTING	NORTHING	BEARING	RADIUS
MLFK					
	0	297983.354	6279907.447	197°21'19.38"	15.000
	6.765	297979.972	6279901.654	223°11'47.03"	STRAIGHT
	15.925	297973.702	6279894.976	223°11'47.03"	52.000
	48.516	297945.622	6279879.508	259°06'20.09"	12.000
	58.518	297936.155	6279881.69	306°51'43.41"	42.000
	66.759	297930.087	6279887.247	318°06'15.38"	116.000
	80.201	297921.71	6279897.75	324°44'38.17"	STRAIGHT
	87.475	297917.511	6279903.69	324°44'38.17"	-25.000
	92.906	297913.921	6279907.751	312°17'48.69"	STRAIGHT
	102.901	297906.527	6279914.478	312°17'48.69"	50.000
	114.424	297898.969	6279923.141	325°30'02.84"	50.000
MKRD					
	0	298001.708	6279897.869	240°15'35.35"	-25.000
	8.697	297995.051	6279892.341	220°19'42.75"	STRAIGHT
	23.109	297985.724	6279881.354	220°19'42.75"	120.000
	45.626	297969.631	6279865.652	231°04'47.29"	-42.000
	56.712	297962.02	6279857.636	215°57'26.22"	-15.000
	63.953	297959.318	6279850.993	188°17'47.32"	24.100
	74.795	297955.434	6279840.969	214°04'14.14"	-30.000
	101.042	297951.455	6279815.864	163°56'28.63"	-30.000
MKRA					
PB	0.000	297937.790	6279801.461	336°09'15.84"	100.000
PT	11.746	297933.683	6279812.458	342°53'03.69"	STRAIGHT
PC	16.948	297932.152	6279817.430	342°53'03.69"	-40.000
PCC	39.609	297919.862	6279836.108	310°25'33.36"	-65.000
PCC	55.400	297906.721	6279844.794	296°30'23.84"	-15.000
PA	68.717	297893.840	6279845.036	245°38'23.51"	-15.000

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
B	06.09.19	MERGE DESIGN INCLUSION (INFORMATION ISSUE)	SH	BDP	TR
A	14.05.18	ACCEPTED FOR CONSTRUCTION	SH	BDP	TR

TITLE	INITIAL	DATE
DRAFTSPERSON	JP	14.05.18
DRAFTING CHECK	SH	14.05.18
DESIGNER	DH	14.05.18
DESIGN CHECK	BDP	14.05.18
PROJECT MANAGER	TR	14.05.18

ORIGINAL DRAWING AT A3 SIZE

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: A.H.D.

0 | 5 | 10 | 15 | 20 | 25 mm ON A3 ORIGINAL

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DRAWINGS / DESIGN PREPARED BY

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SYDNEY OUTER

PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
ROADWORKS
ALIGNMENT SETOUT CONTROL SCHEDULES
SHEET 1

STATUS
FOR INFORMATION

VOLUME	RMS REGISTRATION No	
02	DS2012/000289	
PHASE	DRAWING No	REV
INFO	NB98005-ECC-DG-0232	B

DATE: 6/09/2019 2:18:21 PM LOGIN NAME: HAIL, SCOTT
LOCATION: C:\users\shail\appdata\local\projectwise\ms_projects\dms00629\NB98005-ECC-DG-0232-0235.dwg

ALIGNMENT SETOUT CONTROL - BARRIERS

COD	STATION	EASTING	NORTHING	BEARING	RADIUS
MKBL					
PB	0.000	298016.434	6279621.255	336°57'15.38"	STRAIGHT
PT	128.519	297966.123	6279739.517	336°57'15.38"	-496.500
PT	148.699	297957.848	6279757.921	334°37'31.91"	STRAIGHT
PC	193.965	297938.450	6279798.820	334°37'31.91"	100.500
PA	196.655	297937.330	6279801.265	336°09'31.78"	100.500
MKBR					
PB	1.788	298032.334	6279620.912	327°02'51.63"	234.500
PT	42.334	298013.323	6279656.667	336°57'15.37"	STRAIGHT
PC	136.978	297976.273	6279743.758	336°57'15.37"	500.000
PT	157.300	297968.700	6279762.615	339°16'58.85"	STRAIGHT
PC	191.162	297956.721	6279794.287	339°16'58.85"	89.000
PCC	206.472	297952.560	6279809.001	349°08'21.66"	35.000
PA	213.513	297951.936	6279816.003	00°39'56.75"	35.000

B

ALIGNMENT SETOUT CONTROL - EARTHWORKS

COD	STATION	EASTING	NORTHING	BEARING	RADIUS
MDQ1					
PB	0.000	297989.846	6279849.407	48°42'36.94"	STRAIGHT
PC	4.514	297993.238	6279852.386	48°42'36.94"	-4.750
PT	18.922	297987.374	6279859.842	234°55'30.67"	STRAIGHT
PC	30.497	297977.901	6279853.190	234°55'30.67"	-3.000
PCC	35.943	297977.660	6279848.468	130°54'52.80"	-15.000
PCC	41.553	297982.480	6279845.663	109°29'10.22"	-4.000
PT	45.796	297986.454	6279846.428	48°42'37.22"	STRAIGHT
PA	50.210	297989.771	6279849.341	48°42'37.22"	STRAIGHT

LEGEND

HORIZONTAL CODES (COD)

PB	POINT BEFORE (START)
PC	POINT OF CURVATURE
PT	POINT OF TANGENCY
PCC	POINT OF COMMON CURVATURE
PRC	POINT OF REVERSE CURVATURE
PA	POINT AFTER (END)

NOTE

* PROFILE NOT PROVIDED AND SETOUT INFORMATION CONTAINED IN MODEL

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REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
B	06.09.19	MERGE DESIGN INCLUSION (INFORMATION ISSUE)	SH	BDP	TR
A	14.05.18	ACCEPTED FOR CONSTRUCTION	SH	BDP	TR

0 | 5 | 10 | 15 | 20 | 25 mm ON A3 ORIGINAL This Drawing may have been prepared using colour and may be incomplete if copied

TITLE	INITIAL	DATE
DRAFTSPERSON	JP	14.05.18
DRAFTING CHECK	SH	14.05.18
DESIGNER	DH	14.05.18
DESIGN CHECK	BDP	14.05.18
PROJECT MANAGER	TR	14.05.18

ORIGINAL DRAWING AT A3 SIZE

CO-ORDINATE SYSTEM: MGA Zone 56 HEIGHT DATUM: A.H.D.

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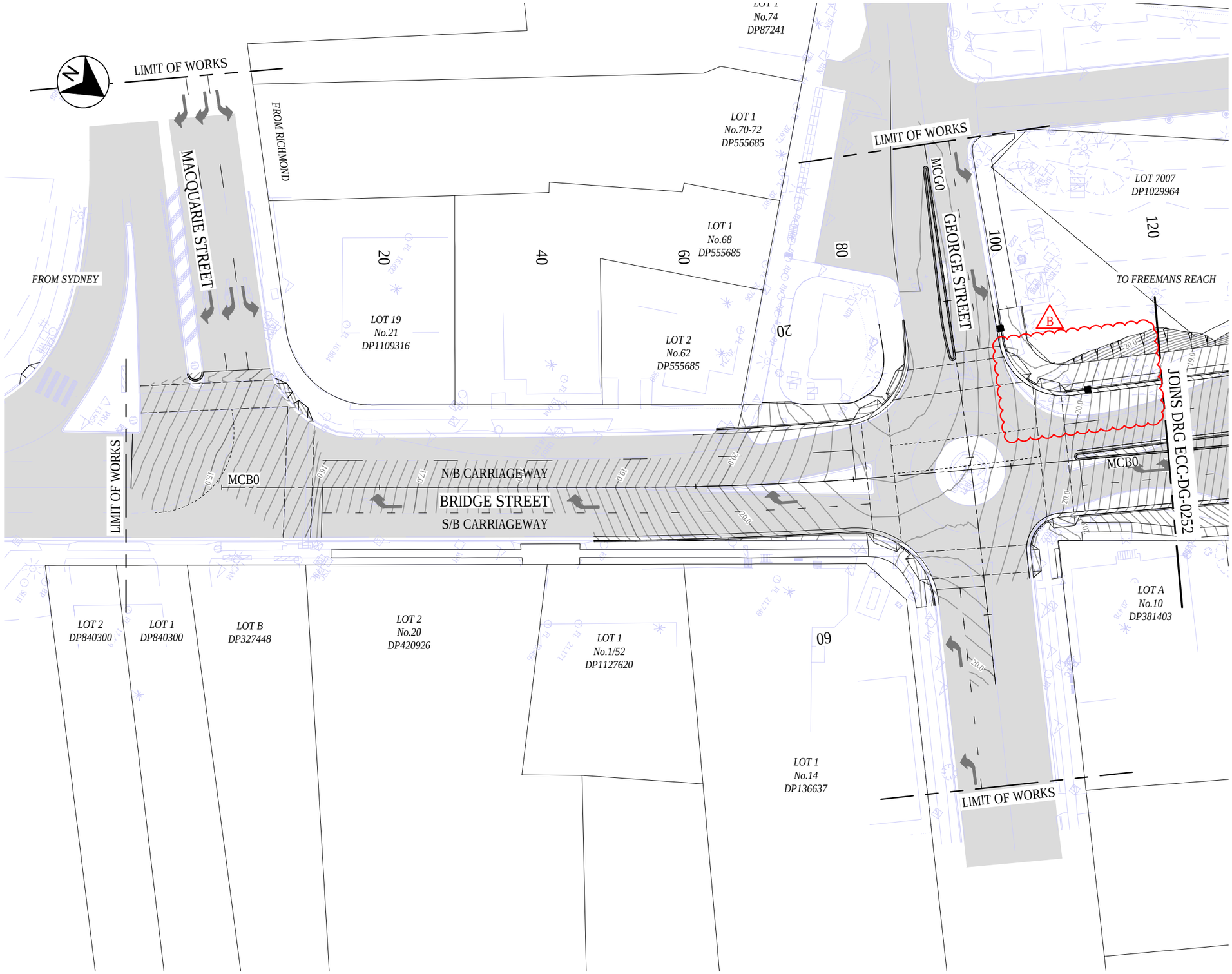
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
ROADWORKS
ALIGNMENT SETOUT CONTROL SCHEDULES
SHEET 4

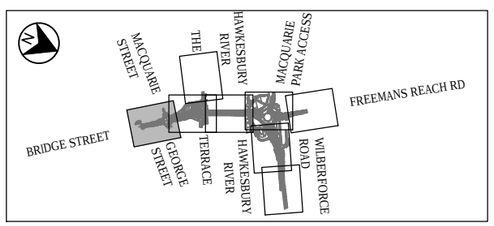
STATUS
FOR INFORMATION

VOLUME	RMS REGISTRATION No	
02	DS2012/000289	
PHASE	DRAWING No	REV
INFO	NB98005-ECC-DG-0235	B



LEGEND

- EXISTING PAVEMENT
- EXISTING PROPERTY BOUNDARY
- CONTROL LINE
- PEDESTRIAN SAFETY FENCE
- RETAINING WALL
- EXISTING EASEMENT BOUNDARY
- STORMWATER PIT (REFER TO VOLUME 3 - DRAINAGE & WATER QUALITY)
- INDICATIVE BRIDGE SCUPPER LOCATIONS
- DRAINAGE HEADWALL



KEY PLAN

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
B	06.09.19	MERGE DESIGN INCLUSION (INFORMATION ISSUE)	SH	BDP	TR
A	14.05.18	ACCEPTED FOR CONSTRUCTION	SH	BDP	TR

0 5 10 15 20 25 mm ON A3 ORIGINAL

TITLE	INITIAL	DATE
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DESIGNER	DH	14.05.18
DESIGN CHECK	BDP	14.05.18
PROJECT MANAGER	TR	14.05.18

ORIGINAL DRAWING AT A3 SIZE

SCALE 1:500 5 0 5 10 AT A3

CO-ORDINATE SYSTEM: MGA Zone 56 HEIGHT DATUM: A.H.D.

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WINDSOR BRIDGE REPLACEMENT
ROADWORKS
GRADING PLAN
SHEET 1

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING
DS2012-000289-DES-WINDSOR-190906

STATUS
FOR INFORMATION

VOLUME	RMS REGISTRATION No	
02	DS2012/000289	
PHASE	DRAWING No	REV
INFO	NB98005-ECC-DG-0251	B

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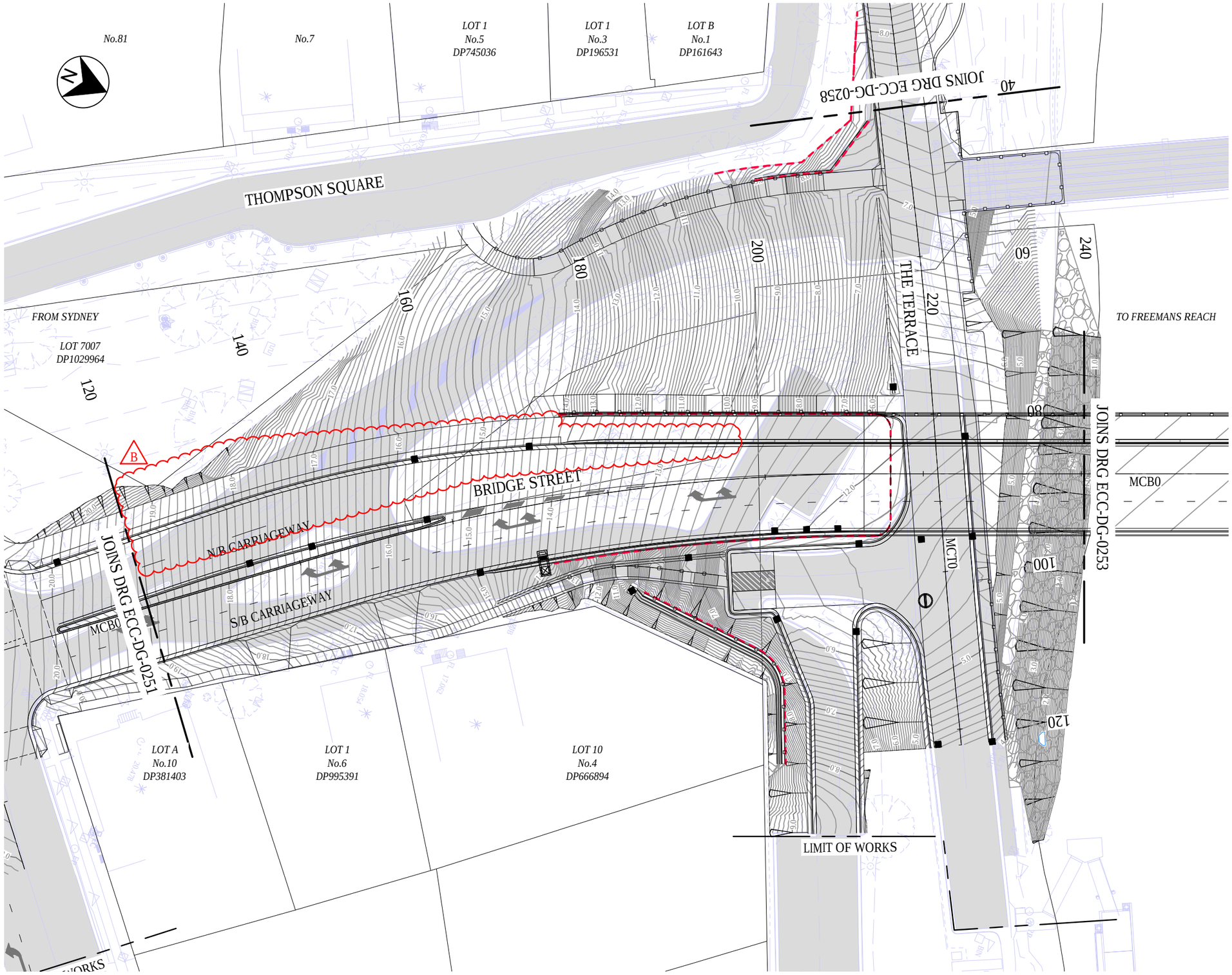
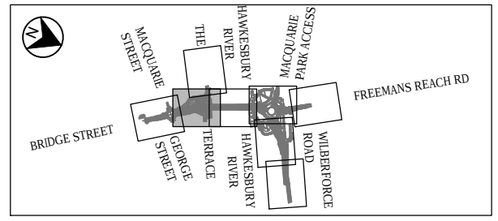


LEGEND

- EXISTING PAVEMENT
- EXISTING PROPERTY BOUNDARY
- CONTROL LINE
- PEDESTRIAN SAFETY FENCE
- RETAINING WALL
- EXISTING EASEMENT BOUNDARY
- STORMWATER PIT (REFER TO VOLUME 3 - DRAINAGE & WATER QUALITY)
- INDICATIVE BRIDGE SCUPPER LOCATIONS
- DRAINAGE HEADWALL



KEY PLAN

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING
DS2012-000289-DES-WINDSOR-190906

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
B	06.09.19	MERGE DESIGN INCLUSION (INFORMATION ISSUE)	SH	BDP	TR
A	14.05.18	ACCEPTED FOR CONSTRUCTION	SH	BDP	TR

TITLE	INITIAL	DATE
DRAFTSPERSON	JP	14.05.18
DRAFTING CHECK	SH	14.05.18
DESIGNER	DH	14.05.18
DESIGN CHECK	BDP	14.05.18
PROJECT MANAGER	TR	14.05.18

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:500 5 0 5 10 AT A3
CO-ORDINATE SYSTEM: MGA Zone 56
HEIGHT DATUM: A.H.D.

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SYDNEY OUTER

PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
ROADWORKS
GRADING PLAN
SHEET 2

STATUS
FOR INFORMATION

VOLUME	RMS REGISTRATION No	
02	DS2012/000289	
PHASE	DRAWING No	REV
INFO	NB98005-ECC-DG-0252	B

DATE: 4/09/2019 9:45:28 AM LOGIN NAME: HAIL, SCOTT
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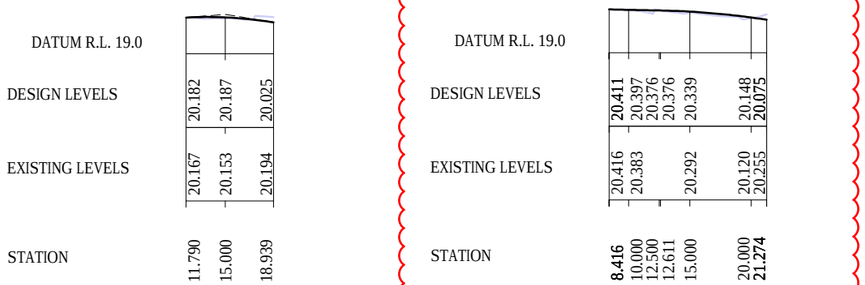
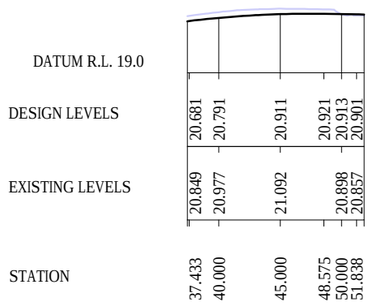
0 5 10 15 20 25 mm ON A3 ORIGINAL This Drawing may have been prepared using colour and may be incomplete if copied

B

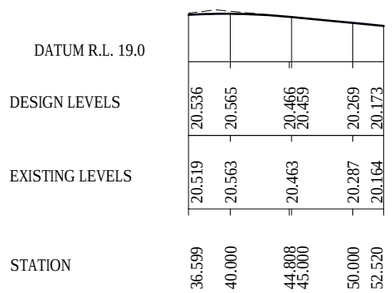


LONGITUDINAL SECTION LIP LINE MKBA

LONGITUDINAL SECTION LIP LINE MKBB



LONGITUDINAL SECTION LIP LINE MKBC



LONGITUDINAL SECTION LIP LINE MKBD

LEGEND

DESIGN SURFACE EXISTING SURFACE

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
B	06.09.19	MERGE DESIGN INCLUSION (INFORMATION ISSUE)	SH	BDP	TR
A	14.05.18	ACCEPTED FOR CONSTRUCTION	SH	BDP	TR

0 5 10 15 20 25 mm ON A3 ORIGINAL

TITLE	INITIAL	DATE
DRAFTSPERSON	JP	14.05.18
DRAFTING CHECK	SH	14.05.18
DESIGNER	DH	14.05.18
DESIGN CHECK	BDP	14.05.18
PROJECT MANAGER	TR	14.05.18

ORIGINAL DRAWING AT A3 SIZE

HORIZ. 1:500 5 0 5 10

VERT. 1:200 2 0 2 AT A3 4

CO-ORDINATE SYSTEM: MGA Zone 56 HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY

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SYDNEY OUTER

PROJECT

HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
PROFILE
KERB LIP LINE
(MKBA, MKBB, MKBC, MKBD)

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING
DS2012-000289-DES-WINDSOR-190906

STATUS **FOR INFORMATION**

VOLUME	BMS REGISTRATION No	
02	DS2012/000289	
PHASE	DRAWING No	REV
INFO	NB98005-ECC-DG-0261	B

DATE: 4/09/2019 9:45:29 AM LOGIN NAME: HAIL, SCOTT
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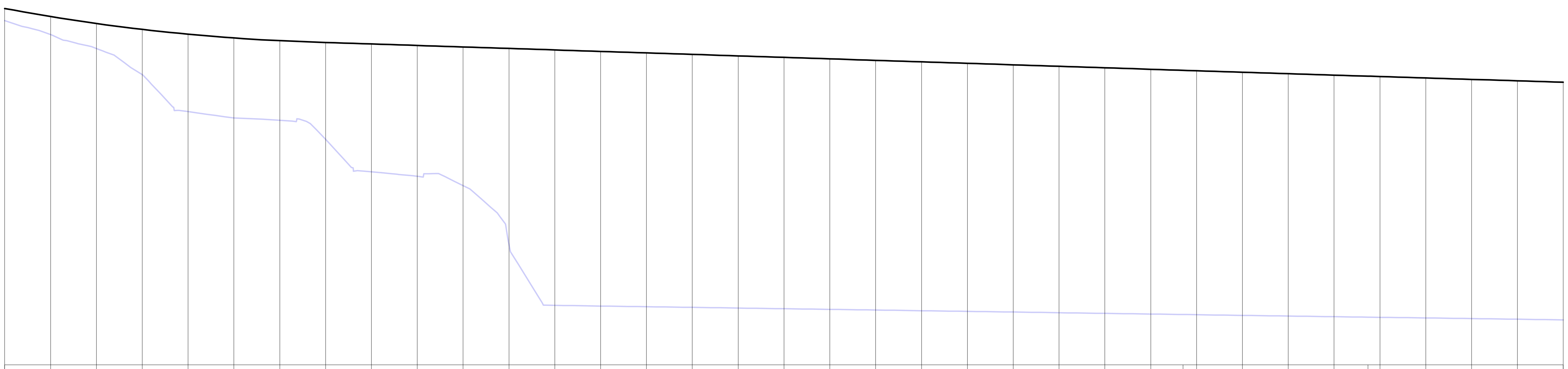
B



DATUM R.L. -2.0

STATION	DESIGN LEVELS	EXISTING LEVELS
0.000	13.522	12.992
5.000	13.170	12.381
10.000	12.865	11.776
15.000	12.610	10.641
20.000	12.404	9.030
25.000	12.236	8.750
30.000	12.119	8.652
35.000	12.040	7.820
40.000	11.975	6.408
45.000	11.910	6.215
50.000	11.845	5.807
55.000	11.780	3.243
60.000	11.715	0.592
65.000	11.651	0.562
70.000	11.586	0.533
75.000	11.521	0.504
80.000	11.456	0.475
85.000	11.391	0.446
90.000	11.327	0.417
95.000	11.262	0.388
100.000	11.197	0.359
105.000	11.132	0.330
110.000	11.067	0.301
115.000	11.003	0.272
120.000	10.938	0.243
125.000	10.873	0.214
128.519	10.827	
130.000	10.808	0.185
135.000	10.744	0.156
140.000	10.681	0.127
145.000	10.618	0.099
148.699	10.572	
150.000	10.556	0.071
155.000	10.494	0.044
160.000	10.433	0.016
165.000	10.371	-0.012
170.000	10.309	-0.040

LONGITUDINAL SECTION BRIDGE SHARED PATH MKBL (NORTHBOUND)

LEGEND

DESIGN SURFACE   EXISTING SURFACE

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LOCATION: C:\Users\shail\AppData\Local\projectwise\rms_projects\dms00629\NB98005-ECC-DG-0261-0282.dwg

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
B	06.09.19	MERGE DESIGN INCLUSION (INFORMATION ISSUE)	SH	BDP	TR
A	14.05.18	ACCEPTED FOR CONSTRUCTION	SH	BDP	TR

TITLE	INITIAL	DATE
DRAFTSPERSON	JP	14.05.18
DRAFTING CHECK	SH	14.05.18
DESIGNER	DH	14.05.18
DESIGN CHECK	BDP	14.05.18
PROJECT MANAGER	TR	14.05.18

ORIGINAL DRAWING AT A3 SIZE
HORIZ. 1:500 VERT. 1:200
5 0 5 10
2 0 2 AT A3 4
CO-ORDINATE SYSTEM: MGA Zone 56   HEIGHT DATUM: A.H.D.

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SYDNEY OUTER

PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
PROFILE
BARRIER
(MKBL) SHEET 1

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING
DS2012-000289-DES-WINDSOR-190906

STATUS
FOR INFORMATION

VOLUME 02   RMS REGISTRATION No DS2012/000289

PHASE INFO   DRAWING No NB98005-ECC-DG-0278   REV B

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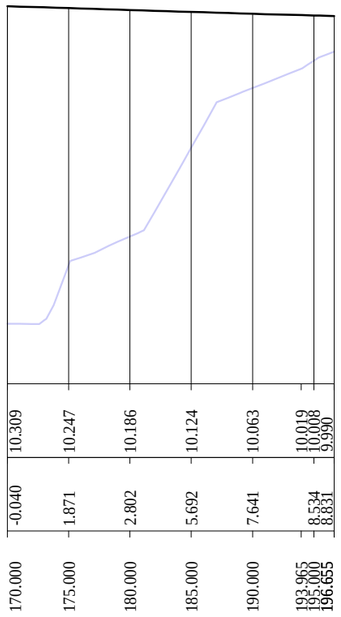
B



LONGITUDINAL SECTION BRIDGE SHARED PATH MKBL (NORTHBOUND)

LEGEND

DESIGN SURFACE EXISTING SURFACE

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
B	06.09.19	MERGE DESIGN INCLUSION (INFORMATION ISSUE)	SH	BDP	TR
A	14.05.18	ACCEPTED FOR CONSTRUCTION	SH	BDP	TR

0 | 5 | 10 | 15 | 20 | 25 mm ON A3 ORIGINAL

TITLE	INITIAL	DATE
DRAFTSPERSON	JP	14.05.18
DRAFTING CHECK	SH	14.05.18
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PROJECT MANAGER	TR	14.05.18

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PROFILE
BARRIER
(MKBL) SHEET 2

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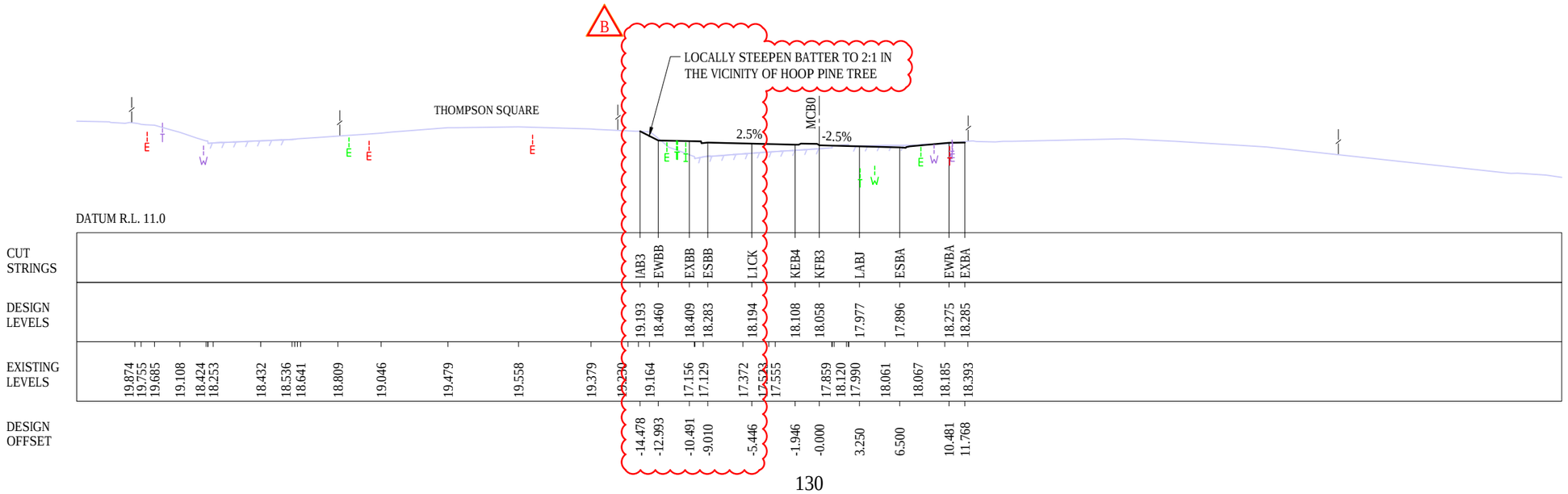

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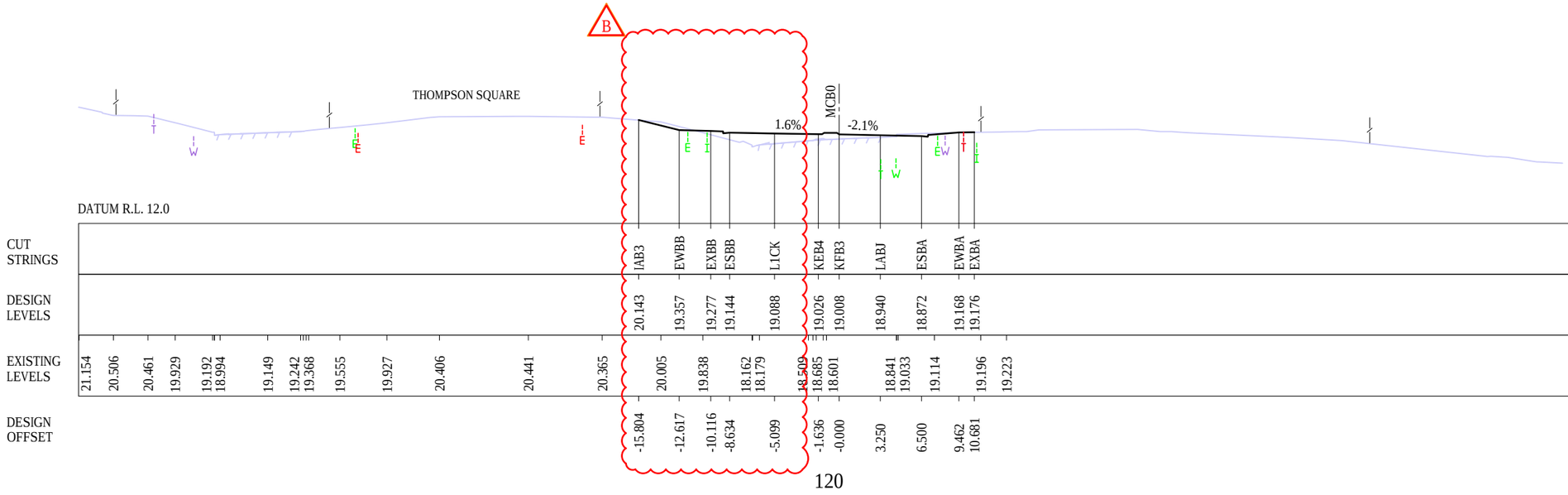

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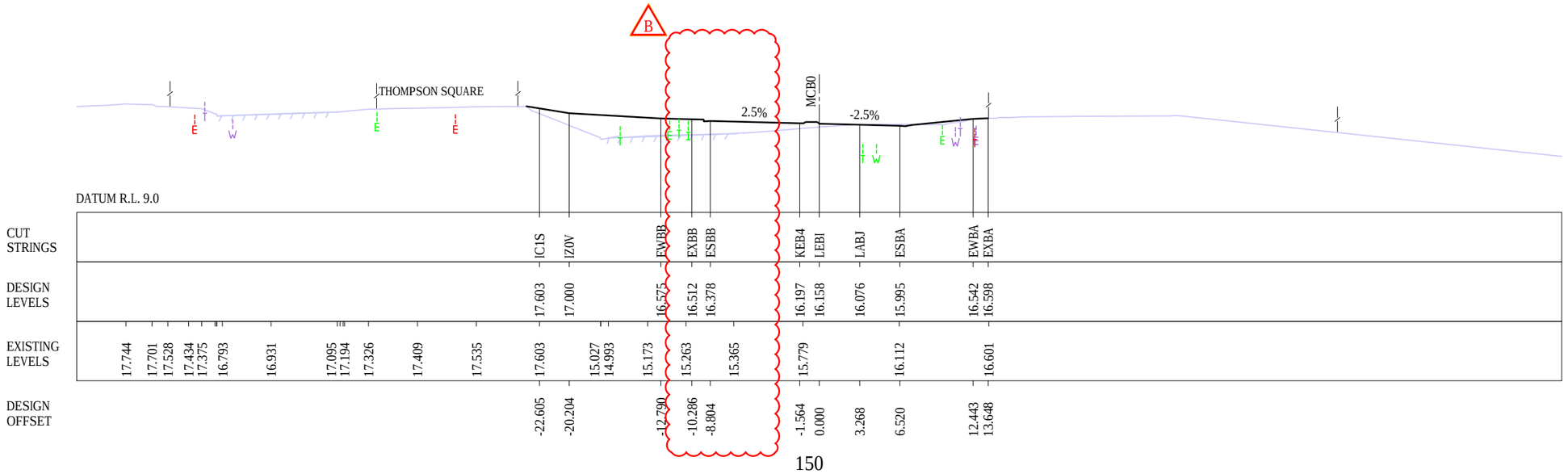

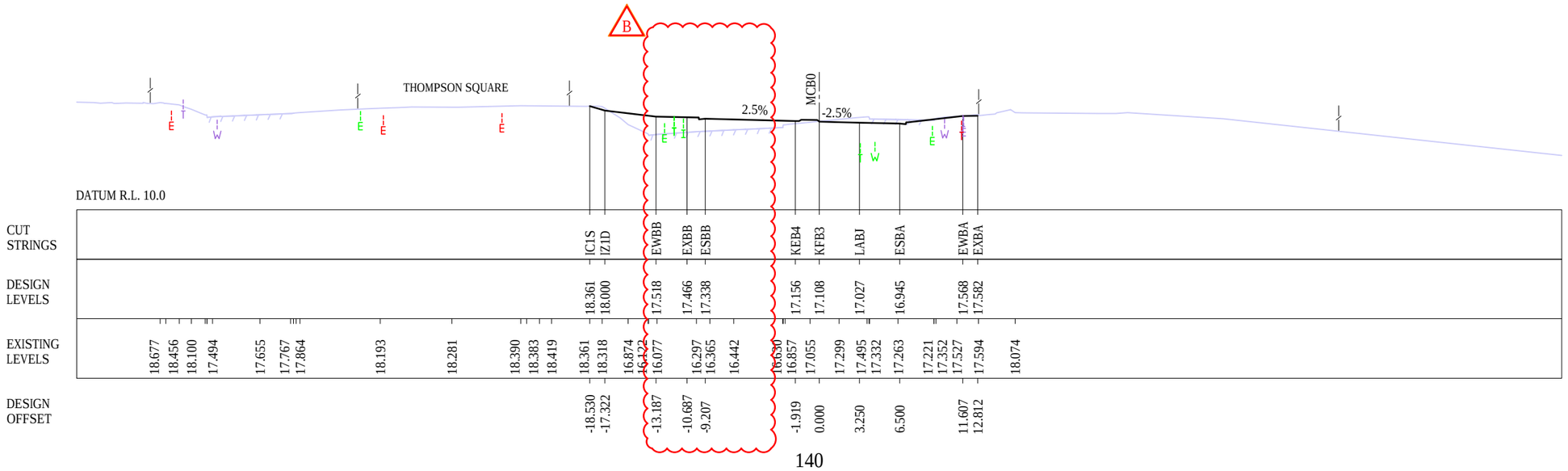

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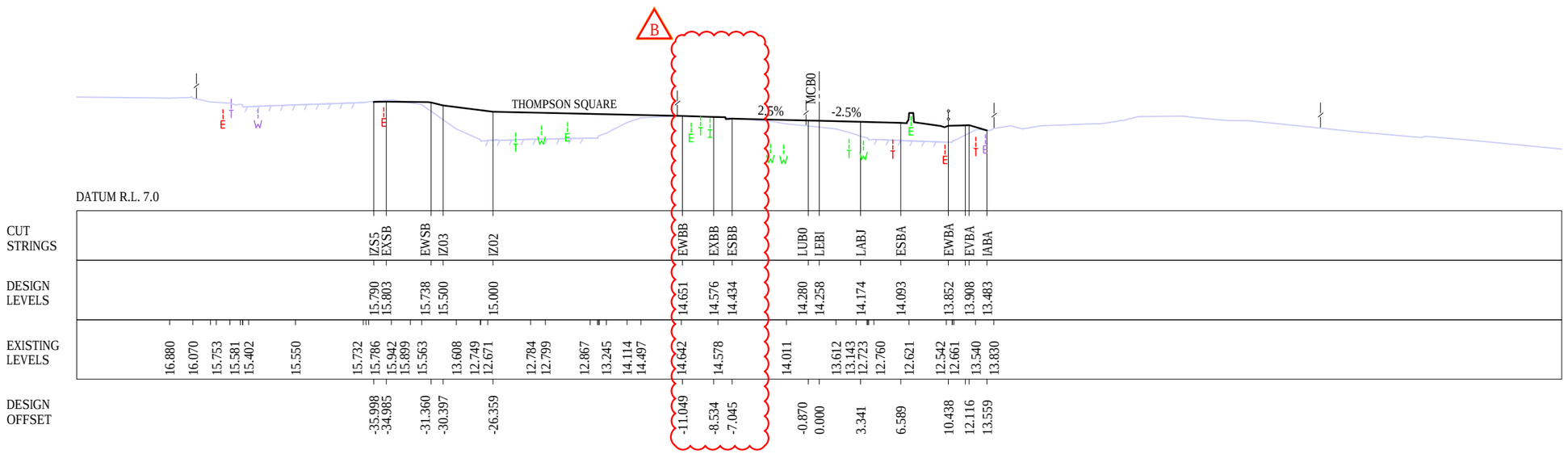

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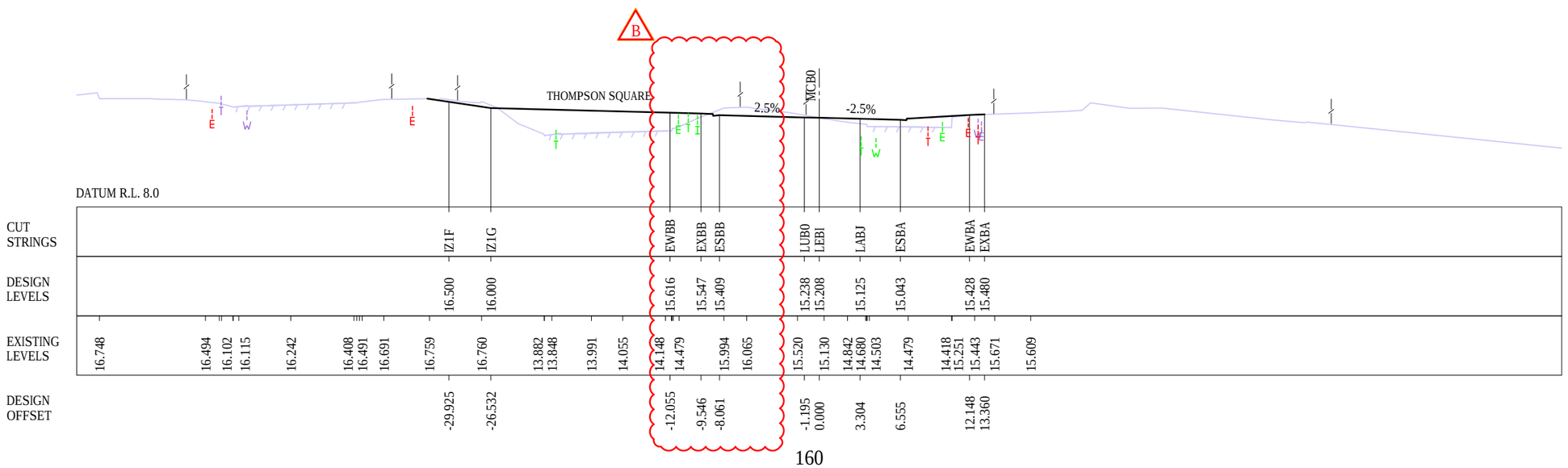

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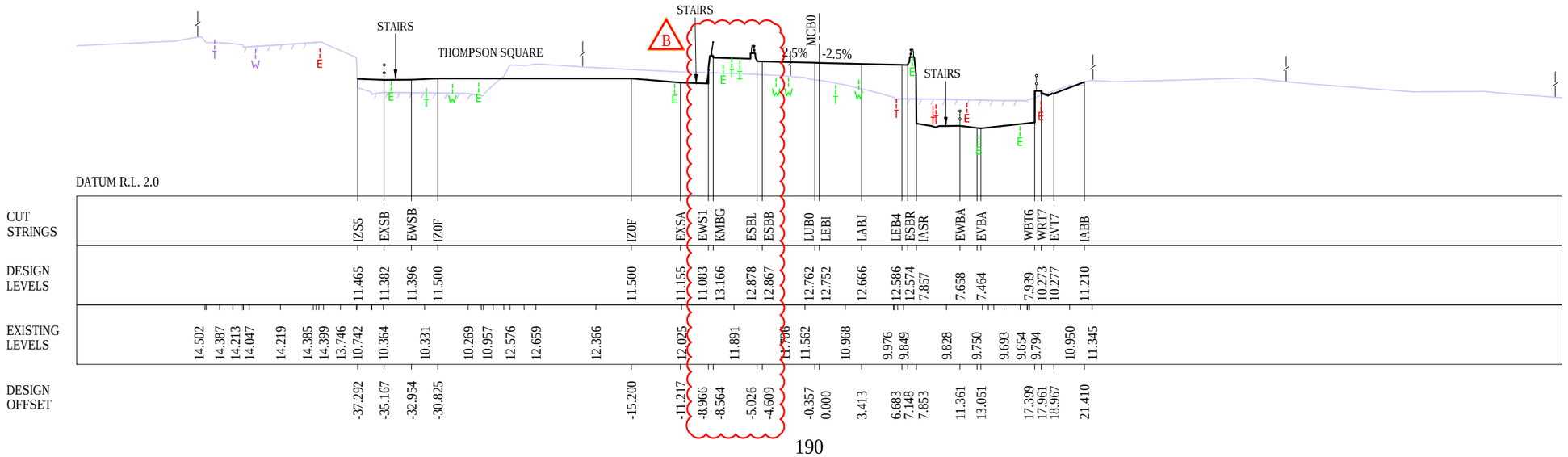

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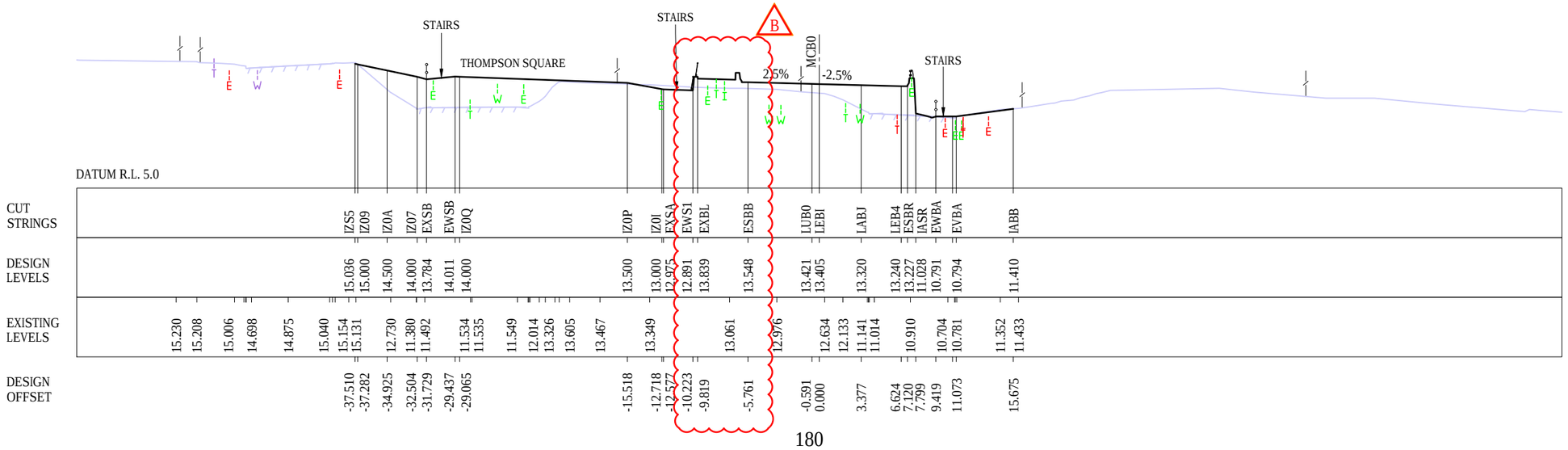

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Appendix B – Traffic and Options Modelling Report

ARCADIS Design & Consultancy for natural and built assets

WINDSOR BRIDGE REPLACEMENT PROJECT

Traffic and Options Modelling Report

Incorporating Hyder

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ROADS AND MARITIME SERVICES (ROADS AND MARITIME) WINDSOR BRIDGE REPLACEMENT PROJECT

Traffic and Options Modelling

Author	Kung Nigarnjanagool; Mikhael Wong	
Checker	Mukit Rahman	
Approver	Mukit Rahman	
Report No	10005593	

REVISIONS

Revision	Date	Description	Prepared by	Approved by
A, B, C, E	May 2017	Draft for internal review	MW, SI	
D	30 May 2017	Draft for Client Review	KN	MR
F	16 June 2017	Draft Final for Client Review	KN	MR
G	21 June 2017	Final Report	KN	MR
H	27 March 2018	Final Report with updated appendix	SI	MR

CONTENTS

APPENDIX

1 Introduction

1.1 Report Purpose

This Traffic and Options Modelling Report is intended to document a traffic and options modelling assessment undertaken for the proposed Windsor Bridge Replacement project (the 'project'). In the course of preparing this report, documents relevant to development of the project were reviewed.

This report documents existing 2017 traffic conditions and future traffic growth in the vicinity of Windsor Bridge, and provides an assessment of performance of the Concept Design of the project from a traffic perspective.

This report has been prepared to assess the network performance of the Concept Design and identify possible cost-effective improvements.

1.2 Background

Roads and Maritime Services (Roads and Maritime) proposes to replace the existing bridge over the Hawkesbury River at Windsor (known as 'Windsor Bridge'), and has developed a Concept Design for this proposal. The project includes a replacement bridge 35 metres downstream from the existing bridge, modifications to the existing intersections, new bridge approach roads to accommodate the new bridge location, and provision of a shared pedestrian and cycle pathway for access to and across the replacement bridge.

The replacement bridge would provide wider lanes and shoulders and greater sight distances for road users in comparison to the existing bridge. Adjustments would also be made to the bridge approach roads and existing intersections at Wilberforce Road / Freemans Reach Road, Bridge Street / George Street, Bridge Street / Count Street and Bridge Street / Macquarie Street. All of these elements of the project would contribute to improvements in traffic capacity and safety.

1.3 Study Area

Figure 1-1 shows the model study area road network and key intersections.

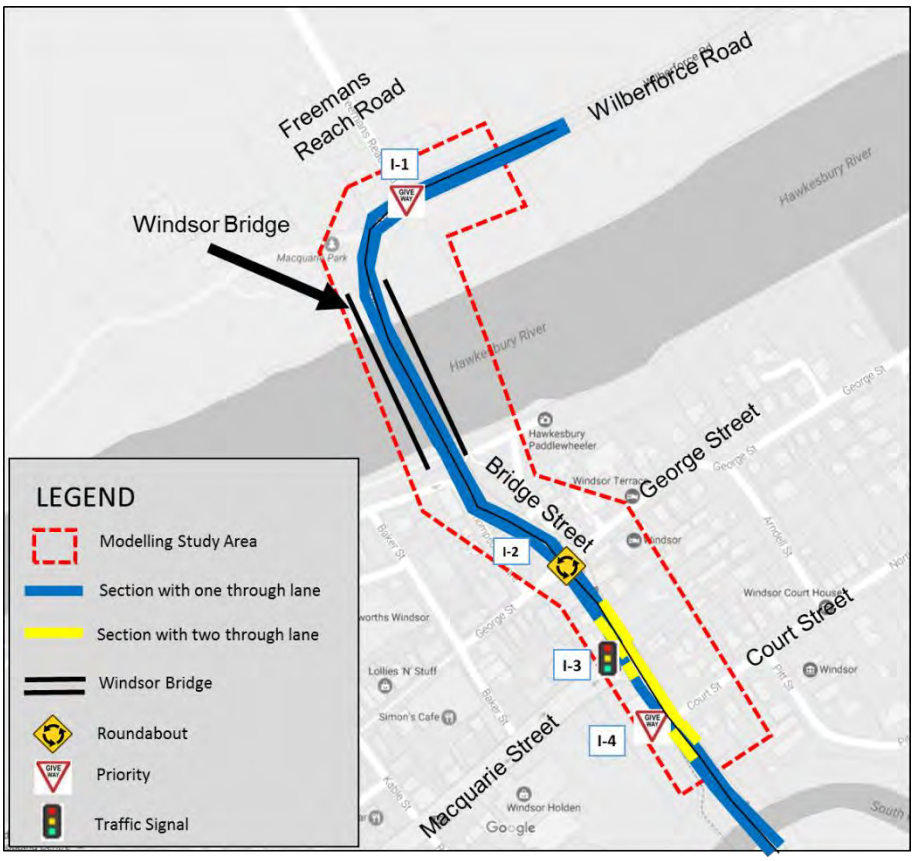


Figure 1-1 Modelling Study Area and Key Intersections

Bridge Street is a sub-arterial road running in a north-west and south-east direction within the study area. It links Windsor Road (A2) and Wilberforce Road from Mulgrave to Windsor. It integrates the existing Windsor Bridge and forms part of the A2. Key intersecting roads include Court Street, Macquarie Street, George Street and Freemans Reach Road. It is primarily one lane in each direction, with additional turning lanes provided at the intersection with Macquarie Street and Court Street. The posted speed limit is 60 km/h and the road bends sharply at both ends of the bridge.

Truck and bus travel speeds are limited to 40 km/h on the bridge. Bridge Street is part of the B-double route from Windsor Road to Wilberforce Road.

Wilberforce Road is a sub-arterial road running north-east and south-west from Bridge Street, connecting Windsor to Wilberforce and forming part of State Route 69 to Singleton. The road is one lane in each direction with a posted speed limit of 80 km/h in the section approaching Windsor Bridge. Wilberforce Road is part of a B-double route running from Windsor Road via Bridge Street.

Key intersections in the study area include:

- Wilberforce Road and Freemans Reach Road;
- Bridge Street and George Street;
- Bridge Street and Count Street; and
- Bridge Street and Macquarie Street.

1.4 Study Scope and Objective

The scope of this study is to assess the Concept Design of the Windsor Bridge Replacement project. Traffic modelling has been undertaken to assess the performance of the Concept Design. A road-based traffic model was developed for the study area using SIDRA Network software version 7.0. Key objectives of the traffic modelling assessment were to:

- Determine the level of service of the proposed upgrades taking into account expected traffic growth for 2026 and 2036; and
- Prepare Traffic and Options Modelling Report.

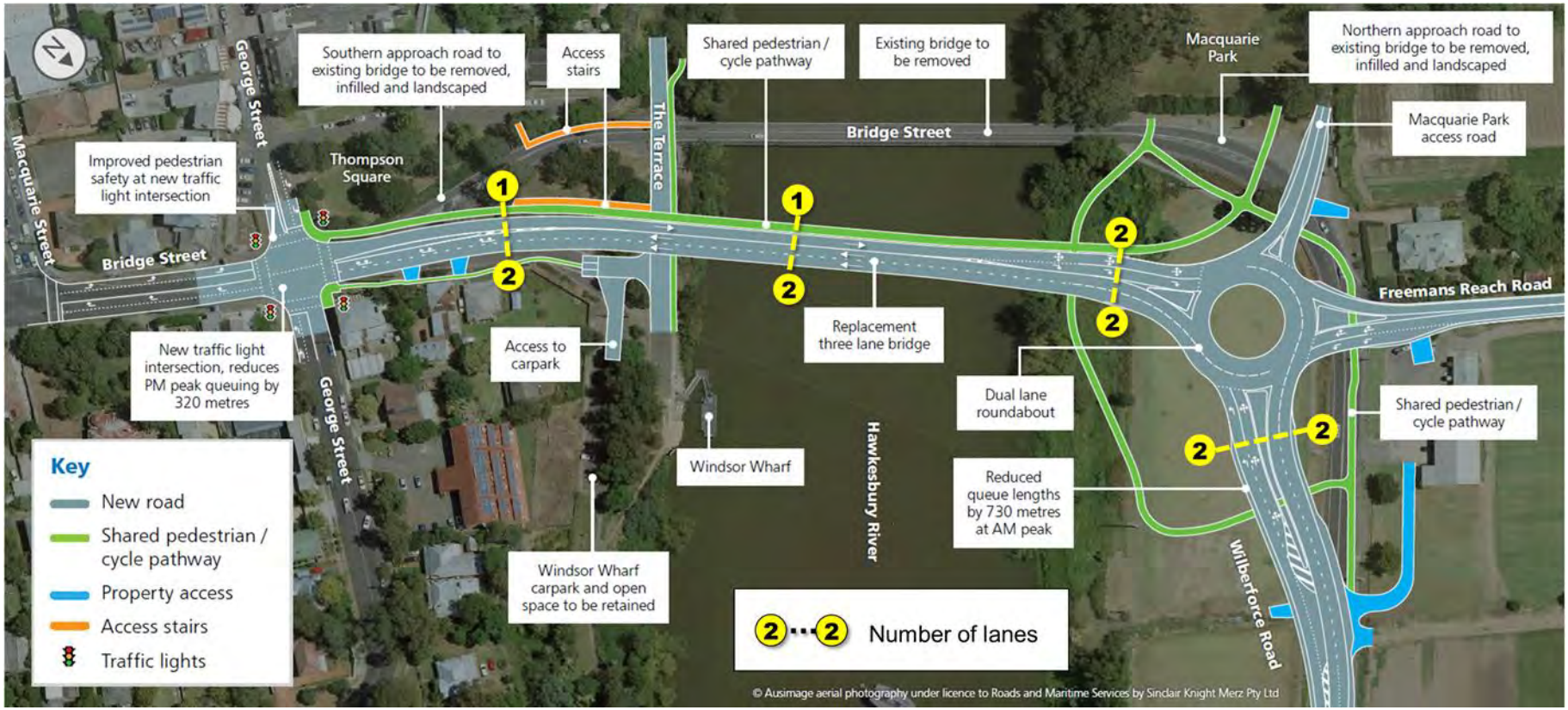
1.5 Concept Design

Roads and Maritime has developed a Concept Design for the Windsor Bridge Replacement project between Wilberforce Road and Court Street, Windsor (hereafter referred to as the 'Concept Design'). The Concept Design involves removal of the existing bridge and construction of a new three lane bridge and upgrade of approach roads and intersections.

The Concept Design includes the following key features:

- Removal of the existing two lane bridge and provision of a new three lane bridge consisting of two lanes in the southbound direction and one lane in the northbound direction;
- A new dual lane roundabout replacing the existing priority control at Bridge Street / Wilberforce Road / Freemans Reach Road. The new roundabout will be located approximately 35 metres south of the Bridge Street / Wilberforce Road / Freemans Reach Road intersection. The new roundabout intersection will form a four-way intersection allowing access to Macquarie Park via the western approach;
- New traffic signals replacing the existing roundabout at Bridge Street / George Street;
- Linemarking the right turn lane on Bridge Street southbound heading to Macquarie Street to formalise it as a turning lane; and
- Linemarking the left turn lane on Bridge Street northbound heading to George Street to formalise it as a turning lane.

Figure 1-2 shows Roads and Maritime's Concept Design.



Source: Source: Windsor Bridge Replacement Project Update, December 2016, Roads and Maritime Services

Figure 1-2 Roads and Maritime's Concept Design

1.6 Study Approach

The study approach involved undertaking a new 2017 traffic survey, traffic analysis based on wider-area strategic traffic modelling obtained from Roads and Maritime's Strategic Traffic Forecasting Model (STFM, EMME model), development of a SIDRA Network model (using SIDRA Network version 7), and assessment of the Concept Design.

Ongoing consultation involving Roads and Maritime project team constituted an important element of this study. Two Technical Notes were prepared and subsequently reviewed by Roads and Maritime project team over the course of this project including:

- Technical Note 1 – Future traffic growth assumption (traffic growth assumptions were agreed with Roads and Maritime project team subsequent to preparation of this Technical Note); and
- Technical Note 2 – Existing conditions and traffic performance of the Concept Design.

Feedback from Roads and Maritime project team was incorporated into the traffic and options modelling study findings at various stages of Arcadis' investigation.

Key steps in Arcadis' modelling approach included the following:

- Analysis of new traffic survey data for the 2017 traffic condition. A new traffic survey was conducted by Matrix in March 2017. This provided key input to development of the base case model. Four types of data were collected including intersection turning movement counts, midblock traffic counts, queue length survey and travel time survey;
- Analysis of future traffic growth using data obtained from Roads and Maritime's Strategic Traffic Forecasting Model (STFM, EMME model), and preparation of traffic forecasts for future years 2026 and 2036;
- Development of SIDRA Network models for the existing year 2017 and future years 2026 and 2036, for both the morning (AM) and afternoon (PM) peaks;
- Assessment of traffic performance of the Concept Design using SIDRA Network, and identification of any modifications to the Roads and Maritime Concept Design; and
- Preparation of a Traffic and Options Modelling Report.

1.7 Reference Traffic Data and Model

For the purpose of the study, future traffic growth data was sourced from Roads and Maritime's Strategic Traffic Forecasting Model (STFM). Arcadis used appropriate traffic growth data from the STFM relevant to the study area. The future growth assumptions to be used in the SIDRA models were then reviewed and agreed with Roads and Maritime project team.

In consultation with Roads and Maritime project team, a new traffic survey was undertaken to satisfy the need and purpose of the study. This included intersection classified turning movement counts (cars and heavy vehicles), midblock traffic counts, queue length, and travel time surveys. This traffic survey was undertaken in March 2017.

To assess network and intersection performance, Arcadis used SIDRA Network modelling software (version 7).

1.8 Report Structure

The remainder of this report is structured as follows:

- **Chapter 2 –** Existing Traffic and Transport **–** Provides context of the existing traffic and transport network within the Windsor Bridge Replacement study area.
- **Chapter 3 –** Existing Road Network Performance **–** Establishes existing traffic performance, summarises traffic survey results, develops the SIDRA Network model for the study area, assesses existing bridge capacity and intersection level of service, and identifies current network issues.
- **Chapter 4 -** Future Traffic Performance of the Upgrade **–** Provides an overview of future traffic growth, forecast traffic volumes on Windsor Bridge, assesses the future traffic performance of the proposed Windsor Bridge Replacement project using the SIDRA Network, and identifies issues and potential modifications to Roads and Maritime's Concept Design.
- **Chapter 5 –** Conclusions **–** Provides a summary of key traffic modelling findings of the study.

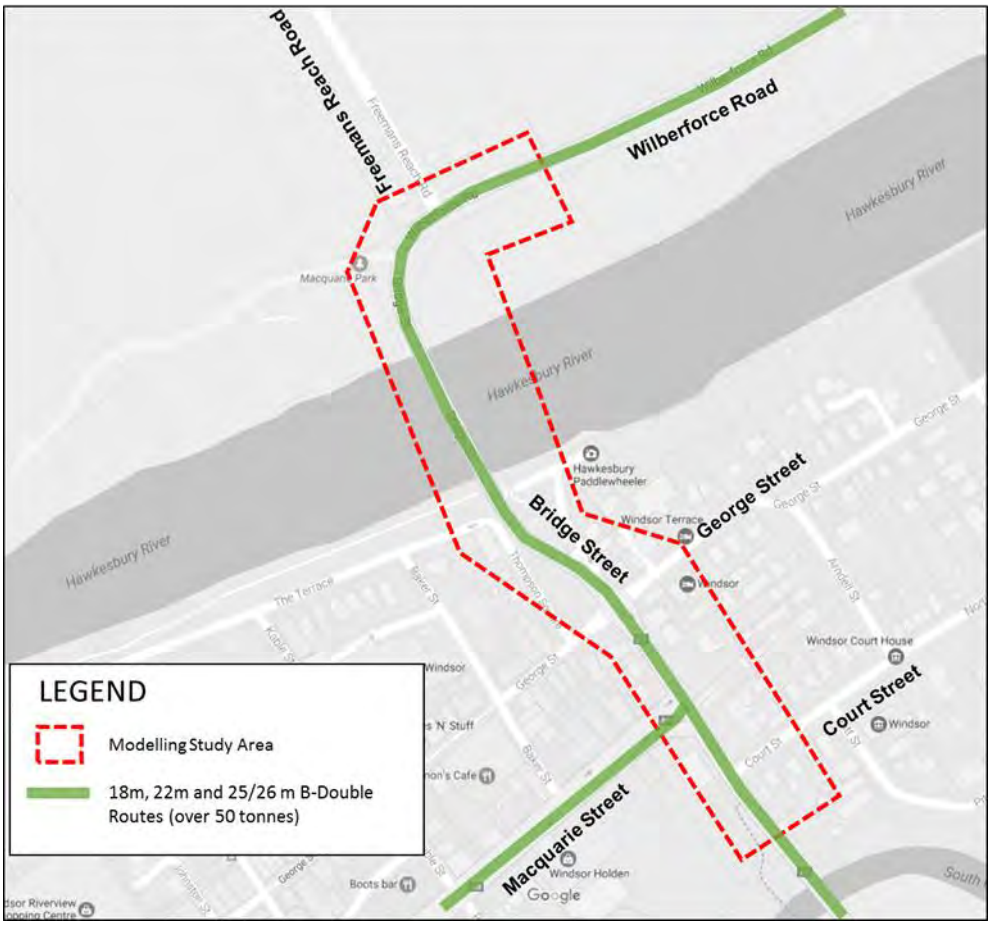
2 Existing Traffic and Transport Conditions

Existing traffic and transport conditions in the study area are described in this chapter. It is intended to provide the traffic context within which the assessment has been undertaken.

2.1 Route and Speed Environment

Bridge Street and Wilberforce Road are sub-arterial roads linking Wilberforce and Windsor to Rouse Hill via Windsor Road to the south and to Wilberforce to the east. Currently Bridge Street and Wilberforce Road are two lane roads (one lane in each direction).

Bridge Street, Wilberforce Road and Macquarie Street are designated B-double routes for trucks up to 26 metres long. Figure 2-1 shows designated B-double routes in the study area (sourced from Roads and Maritime).



Source: RMS Restricted Access Vehicle Map NSW (map as of 27 March 2017)

Figure 2-1 Designated B-Double Routes in the Study Area

The posted speed limit on Bridge Street and Wilberforce Road between Court Street and Freemans Reach Road is 60 km/h. Over the Windsor Bridge, the posted speed limit for trucks and buses is 40 km/h. The speed limit on Bridge Street and Wilberforce Road increases to 80 km/h approximately 550 metres south of Court Street and 200 metres east of Freemans Reach Road. The posted speed limit on George Street and Court Street is 50 km/h. The posted speed limit on Macquarie Street is 60 km/h. Freemans Reach Road has a posted speed limit of 80 km/h decreasing to 60 km/h

approaching the intersection with Wilberforce Road. Figure 2-2 shows posted speed limits in the vicinity of the study area.

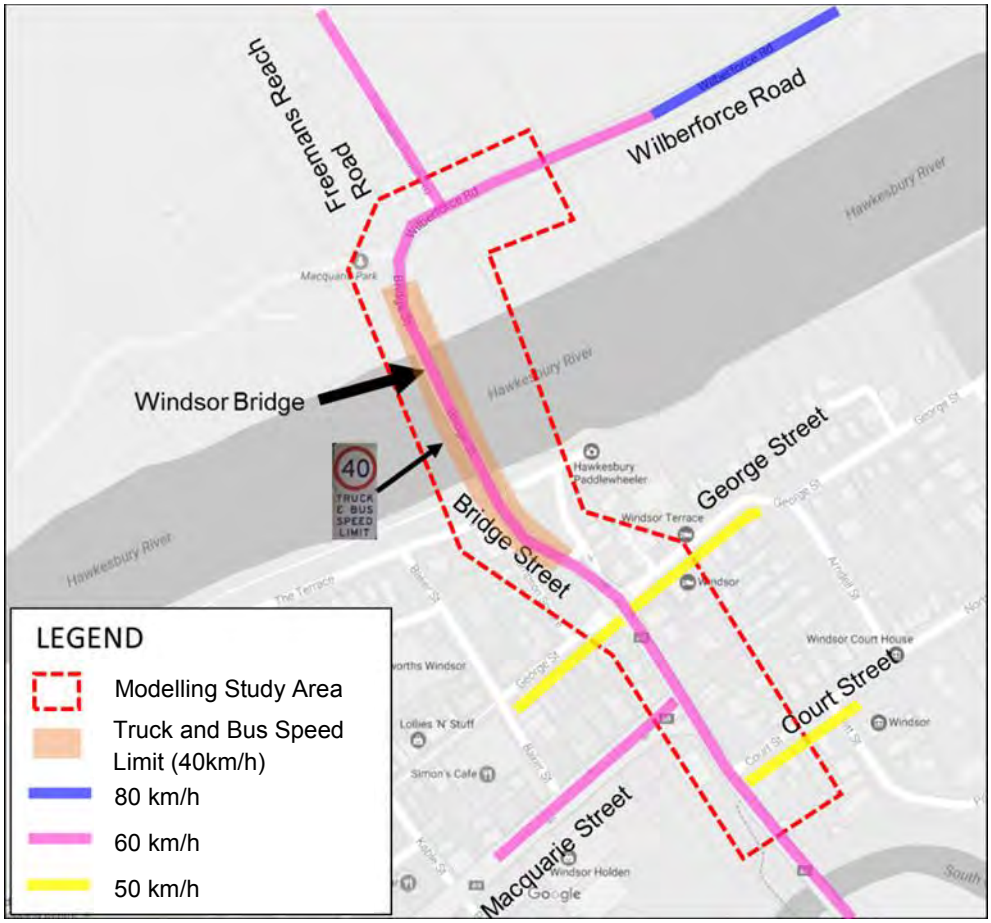
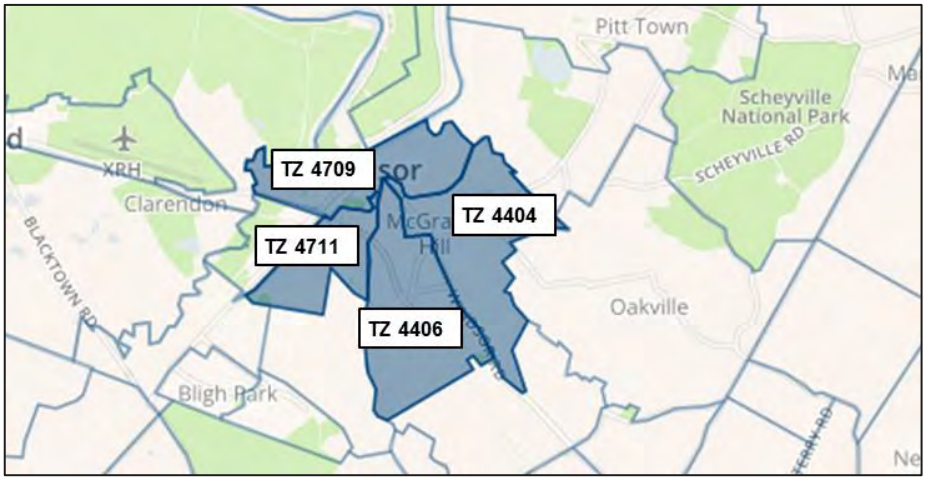


Figure 2-2 Posted Speed Limits in the Study Area

2.2 Commuter Mode Share

Transport Performance and Analytics (TPA) provides journey to work data (JTW) for the Sydney Greater Metropolitan Area (GMA), which comprises a comprehensive sample of commuter travel collected during the 2011 Census. Work trip origin and destinations are coded to the 2011 travel zones and shown in Figure 2-3. Table 2-1 summarises the work trips by mode of travel reported for the study area.



Source: Transport Performance and Analytics (TPA)

Figure 2-3 Travel Zones in the Study Area

Table 2-1 Commuter Mode Share in Study Area

Travel Mode	Study Area as Workplace (Outbound trips)	Study Area as Workplace (Outbound trips) %	Study Area as Home (Inbound trips)	Study Area as Home (Inbound trips) %
Car Driver	1,621	70%	4,928	76%
Car Passenger	119	5%	412	6%
Train	125	5%	118	2%
Bus	17	1%	30	0%
Ferry/ Tram	1	0%	5	0%
Walked Only	79	3%	97	1%
Other	28	1%	46	1%
Worked at home/ Did not travel/ Not stated	326	14%	891	14%
Total	**2,317**	**100%**	**6,525**	**100%**

Selected travel zones (TZ11): 4404, 4406, 4709, 4711

Source: 2011 Journey to Work Data

In 2011, about 2,317 residents travelled from the study area to work. About 14 per cent of people did not travel to work or worked from home on Census day. The Census data showed that around 75 per cent of work trips from the study area were made by motorists in a private vehicle, with five per cent of those as car passengers. About six per cent of workers travelled by public transport, and three per cent walked. Of the five per cent public transport users, only one per cent of the trips were made by bus, with the remaining five per cent of trips made by train.

In 2011 about 6,525 employees travelled to the study area from work. From the inbound trip statistics, it can be seen that private vehicles are still the dominant mode of transport to work, accounting for about 82 per cent. About two per cent of employees travelled by public transport and one per cent walked. The percentage of people who did not go to work or worked from home remained at 14 per cent when compared to outbound trips.

2.3 Work Trips Distribution

The JTW data was further analysed to understand the distribution of work trips to and from study area. Outbound work trip distribution made by private car (both as driver and as passenger) from the study area are summarised in Table 2-2. Inbound work trips distribution made by private car (both as driver and as passenger) to the study area are summarised in Table 2-3.

The results indicate the following work trip patterns:

- Outbound work trip distribution shows that substantial trips are made to Richmond - Windsor (25 per cent) and Rouse Hill – McGraths Hill (16 per cent). In addition to this, 9 per cent of outbound trips travelled to Blacktown.
- Inbound work trip distribution shows that substantial trips are made from Richmond - Windsor (27 per cent) and Hawkesbury (20 per cent). In addition to this, 11 per cent of inbound trips travelled from Rouse Hill – McGraths Hill.

Table 2-2 Daily Car Trips from the Study Area (Outbound)

Geographic Area	Number of car trips from study area (Outbound)	% Outbound trips from Study Area
Richmond - Windsor	434	25%
Rouse Hill - McGraths Hill	276	16%
Blacktown	163	9%
Baulkham Hills	126	7%
Mount Druitt	76	4%
Penrith	76	4%
Parramatta	59	3%
Hawkesbury	58	3%
Dural - Wisemans Ferry	52	3%
Other	303	17%
Total	**1,740**	**100%**

Source: 2011 Journey to Work Data

Table 2-3 Daily Car Trips to the Study Area (Inbound)

Geographic Area	Number of car trips to study area (Inbound)	% Inbound trips to Study Area
Richmond - Windsor	1,424	27%
Hawkesbury	1073	20%
Rouse Hill - McGraths Hill	587	11%
Blacktown	499	9%
Penrith	472	9%
Mount Druitt	222	4%
Baulkham Hills	209	4%
Blue Mountains	175	3%
Dural - Wisemans Ferry	121	2%
St Marys	106	2%
Other	453	8%
Total	**5,339**	**100%**

Source: 2011 Journey to Work Data

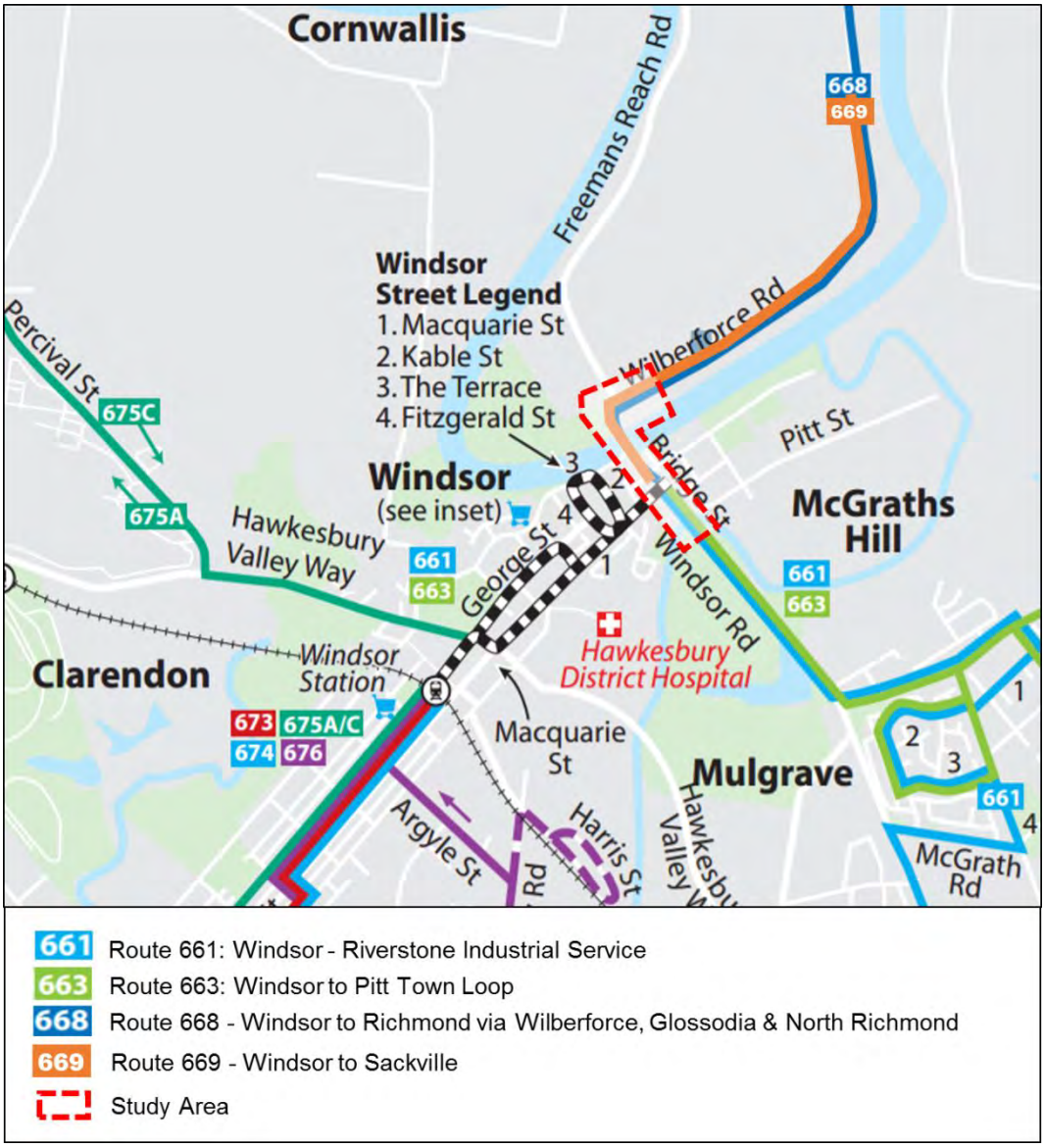
2.4 Travel Patterns

Significant proportions of morning (AM) and afternoon (PM) peak trips to and from the study area have an origin and destination to the surrounding areas including Richmond, Hawkesbury, Rouse Hill and Blacktown. Analysis of travel patterns from the journey to work (JTW) data indicated that approximately 67 per cent of the catchment area's workers live in Richmond, Hawkesbury, Rouse Hill and Blacktown.

The JTW data indicated about 54 per cent of the catchment area's residents travelled to Richmond, Hawkesbury, Rouse Hill and Blacktown.

2.5 Public Transport

The study area is serviced by four routes all operated by Busways. Routes 661, 663, 668 and 669 run along Bridge Street, Wilberforce Road and Macquarie Street. Figure 2-4 shows the bus routes in the study area.



https://www.busways.com.au/sites/default/files/network_maps/R1TimetableNetworkMap201116.pdf

Figure 2-4 Bus Routes Servicing the Study Area

The study area has no direct rail service. The nearest railway station by road is Windsor Station (see Figure 2-5). Windsor Station is approximately two kilometres away from Bridge Street via Macquarie Street and George Street.

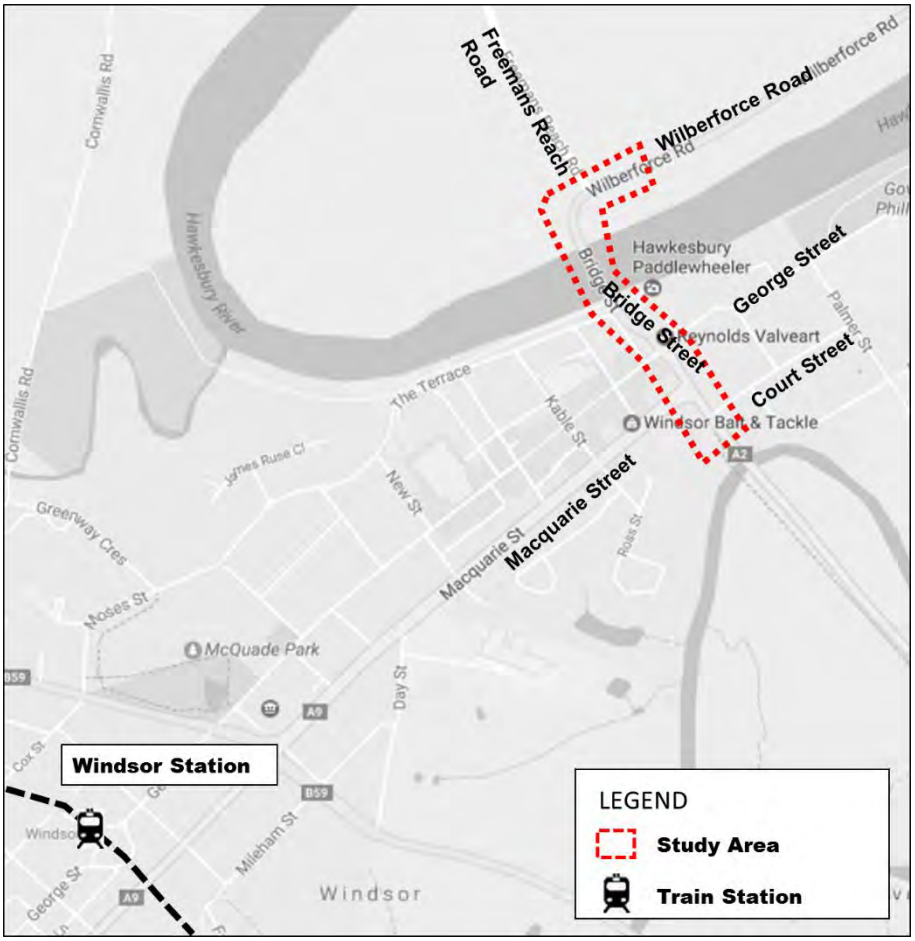


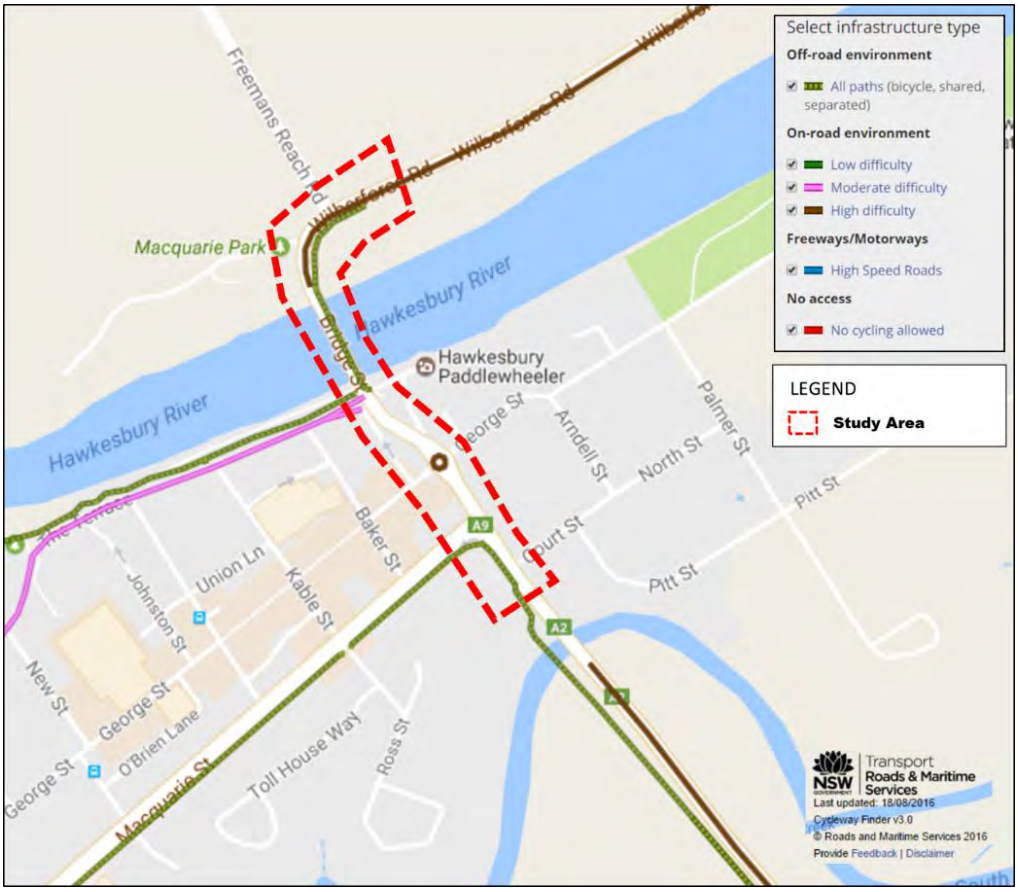
Figure 2-5 Train Stations in Close Proximity to the Study Area

2.6 Walking and Cycling

There are dedicated footpaths along Bridge Street, Macquarie Street, George Street and Court Street. Windsor Bridge has a narrow pedestrian and cycle path on its eastern side. This shared path links The Terrace and Old Bridge Street in the south with the intersection of Wilberforce and Freemans Reach Roads to the north. The shared path on the existing bridge also forms an off-road link in the local cycle network.

Pedestrian access and amenity at the Bridge Street / George Street roundabout is currently poor. Pedestrian access is typically poor at roundabout controlled intersections and is made worse in this case by the fact that the intersection is located at the top of a crest. The existing intersection presents a road safety hazard for pedestrians and cyclists due to the high peak traffic volumes and poor sight distance at the intersection. No facilities are provided at the current roundabout controlled intersection to assist crossing Bridge Street, and pedestrians have difficulty identifying a safe gap in which to cross during peak traffic periods. As well as being a considerable safety risk to pedestrians crossing at this point, it provides a barrier to pedestrian movements from the eastern section of the town, where much of the accommodation is located, to the town centre.

An on-road cycle way is currently provided on Bridge Street and Wilberforce Road. A designated off-road cycle way exists on Bridge Street, Wilberforce Road and Macquarie Street. Figure 2-6 shows the different types of cycle routes in the study area.



Source: Roads and Maritime Cycleway Finder V3

Figure 2-6 Existing Cycleways in the Study Area

2.7 Crash Data

This assessment is based on the crash data supplied by Roads and Maritime between July 2011 and December 2016. The crash data includes fatal, injury or vehicle damage accidents. The crash analysis was undertaken for Bridge Street and Wilberforce Road between Freemans Reach Road and Macquarie Street.

Table 2-4 below summarises recorded crashes by road and location. There were 52 crashes recorded between July 2011 and December 2016 on Bridge Street and Wilberforce Road between Freemans Reach Road and Macquarie Street. Of all crashes reported, 41 crashes occurred at intersections, 8 crashes occurred on the undivided road sections, and 3 crashes occurred on the divided road sections.

The severity of crashes classified as fatal, injury and non-casualty are shown in Table 2-5. Of the total 52 crashes recorded in the study area between July 2011 and December 2016, no fatal crashes were recorded. About 20 crashes (38 per cent) were recorded as injury, with 20 people injured in total. About 32 crashes (62 per cent) were recorded as non-casualty (i.e. tow-away).

Table 2-4 Locations of Crashes

Road	Total Number Crashes Recorded	Intersection*	Non-intersection	
			Two-way undivided road	Divided Road
Bridge Street	23	17	4	2
George Street	1	1	0	0
Macquarie Street	4	3	0	1
Wilberforce Road	24	20	4	0
Total	**52**	**41**	**8**	**3**

*Source: Roads and Maritime crash data between July 2011 and December 2016, Note: * Up to 10 metres from an intersection*

Table 2-5 Number of Crashes by Severity

Crash Severity	Number of Crashes Recorded	%	Casualties
Fatal	0	0%	
Injury	20	38%	20 people injured
Non-casualty	32	62%	
Total	**52**	**100%**	**20**

Figure 2-7 shows the number of crashes per movement type. The four most common types of crashes account for around 87 per cent of the reported crashes within the study area:

- Intersection, from adjacent approaches (38 per cent);
- Opposing vehicles, turning (21 per cent);
- Rear-end (15 per cent); and
- Off carriageway, on curve, hit object (8 per cent).

Crashes other than the above constitute the remaining 17 per cent.

It is likely that safety will deteriorate along Bridge Street and Wilberforce Road and associated intersections in their current configuration for all road users as traffic levels and congestion increase, which is of ongoing and substantial concern to Roads and Maritime and the local community.

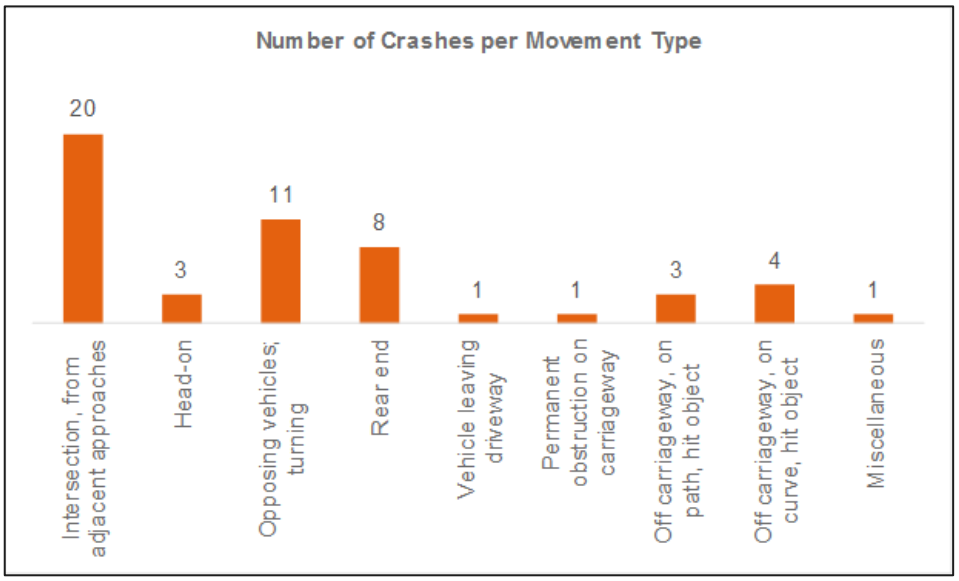


Figure 2-7 Number of Cashes by Movement Types

Figure 2-8 shows crash locations on Bridge Street and approach roads. Figure 2-8 indicates that crashes are mostly located at intersections. Particularly crash-prone locations are:

- Freemans Reach Road and Wilberforce Road intersection;
- Bridge Street and George Street intersection; and
- Bridge Street and Macquarie Street intersection.

Figure 2-8 Spatial Distribution of Crashes on Bridge Street and Approach Roads

3 Existing Road Network Performance

This chapter establishes existing transport network performance in the study area. Results of the new 2017 traffic survey are summarised in this section, and formed the basis of the SIDRA model and level of service assessment.

3.1 Traffic Surveys

The 2017 traffic survey was undertaken by Matrix in March 2017 to satisfy the needs and purpose of the study. It included:

- Daily automatic traffic counts;
- Intersection turning movement counts;
- Queue length surveys; and
- Travel time surveys.

3.1.1 Mid-block traffic counts

Daily mid-block traffic survey was conducted on the Windsor Bridge for a continuous seven-day period between 24 March 2017 and 30 March 2017. The mid-block data was collected to identify the thirteen Austroads standard vehicle classes.

3.1.2 Intersection counts and queue length surveys

Intersection turning movement counts and queue length surveys were conducted on 28 March 2017 (Tuesday) for two hours in the AM (07:00-9:00) and two hours in the PM (16:00-18:00).

The survey was conducted for the following four intersections:

- Wilberforce Road / Freemans Reach Road;
- Bridge Street / George Street;
- Bridge Street / Macquarie Street; and
- Bridge Street / Court Street.

3.1.3 Travel time and speed surveys

Travel time surveys were conducted on 28 March 2017 (Tuesday) for two hours in the AM (07:00-9:00) and two hours in the PM (16:00-18:00).

The survey was conducted for one bi-directional route:

- Bridge Street / Wilberforce Road (between 500 metres south of Court Street / Bridge Street intersection and 500 metres east of Freemans Road / Wilberforce Road intersection)

Figure 3-1 below shows the survey locations for midblock counts, intersection counts, queue length and travel time surveys.

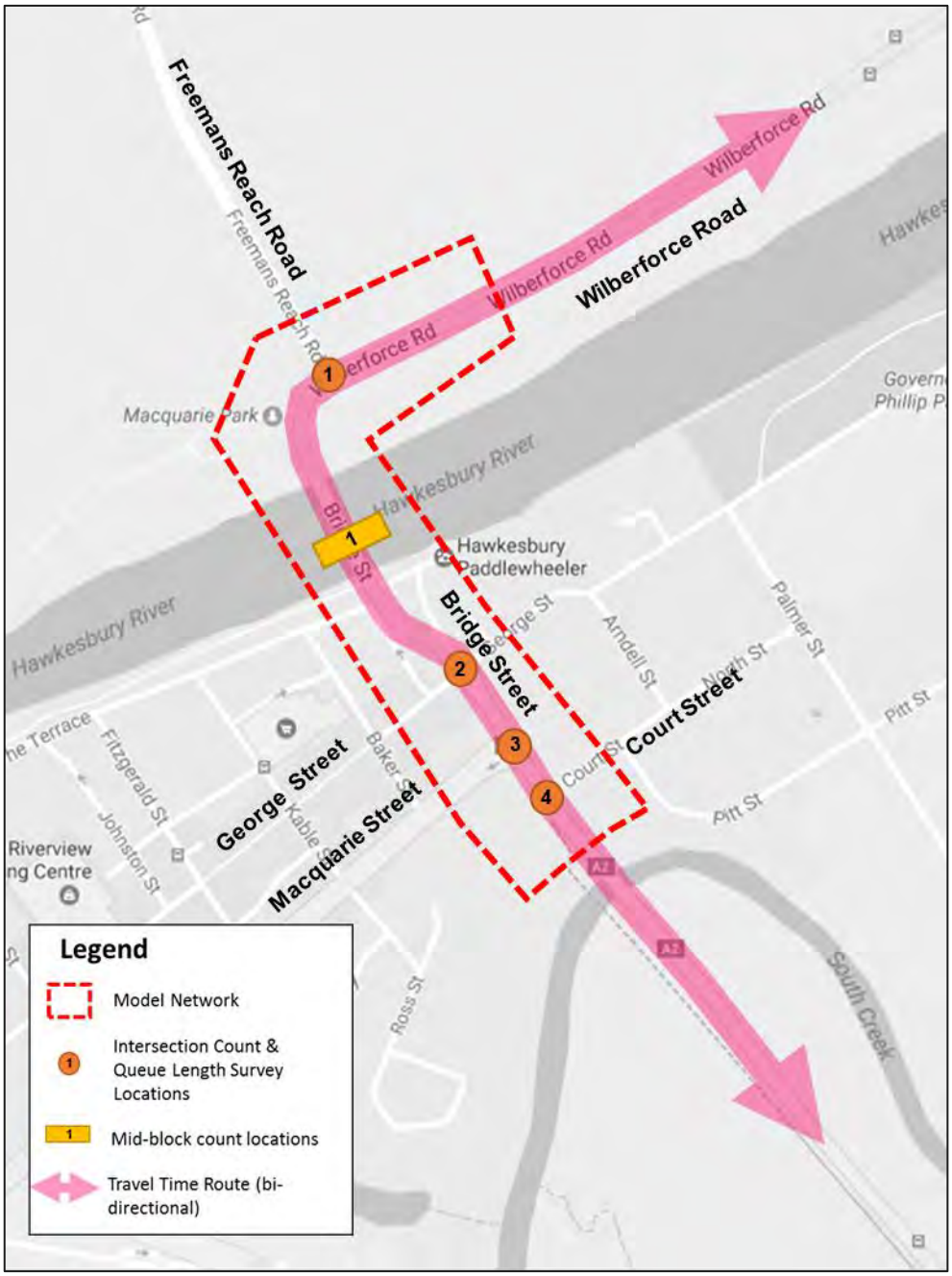


Figure 3-1 Traffic Survey Locations

3.2 Traffic Results

This section quantifies the current 2017 daily and peak hour traffic flows on Windsor Bridge and adjoining intersections within the study area. The peak hour intersection turning movements for AM and PM are used to estimate the current level of service at modelled four intersections.

3.2.1 Daily Traffic Volumes on Windsor Bridge

The 2017 midblock count represents data obtained from the March 2017 traffic survey. Table 3-1 shows the daily 2017 traffic volumes counted on Windsor Bridge (Bridge Street over Hawkesbury River).

Table 3-1 Daily traffic volume on Windsor Bridge in 2017

Day	Total Vehicles	Heavy Vehicles	Heavy Vehicle %
Monday	21,000	2,300	11%
Tuesday	21,400	2,400	11%
Wednesday	22,300	2,600	12%
Thursday	21,200	2,300	11%
Friday	21,900	2,200	10%
Saturday	17,800	1,300	8%
Sunday	15,800	1,000	6%
Average weekday (5 days)	21,600	2,400	11%
Average weekly (7 days)	20,200	2,000	10%
Average weekend (2 days)	16,800	1,200	7%

The daily traffic volumes are shown for average weekly (7 days) and average weekday (5 days) including heavy vehicles.

- Currently (2017), Windsor Bridge (Bridge Street over Hawkesbury River) carries between 21,000 and 22,300 vehicles per day on weekday (Monday to Friday) with average of 21,600 vehicles per day;
- Based on averaged weekday (5 days), Windsor Bridge carries about 2,400 heavy vehicles per day representing about 11per cent of total volumes; and
- Weekend (Saturday and Sunday) traffic is significantly lower than weekday traffic, being about 22 per cent lower than weekday average (5 days).

Figure 3-2 shows the 2017 average weekday volume on Windsor Bridge.

Figure 3-2 Average Daily Traffic (Weekday) in 2017

3.2.2 Heavy Vehicle Volumes

According to the Austroads vehicle classification system, heavy vehicles include trucks with two or more axles, buses, semi-trailers and B-doubles.

Table 3-2 below summarises the 2017 daily heavy vehicles counted on Windsor Bridge. Based on average weekday data, the number of heavy vehicles recorded on Windsor Bridge is about 2,400 vehicles per day, representing about 11 per cent of the total vehicles.

Table 3-2 Daily Traffic Volumes (vehicles) on Bridge Street and Wilberforce Road in 2017

Road Section	Average Daily Traffic	Heavy Vehicles	% Heavy Vehicles
Windsor Bridge (Bridge Street)	21,600	2,400	11%

3.2.3 Hourly Traffic Variation

Hourly traffic variations on Windsor Bridge were analysed for seven days (Monday to Sunday) to establish peak hour traffic patterns throughout the day. Figure 3-3 shows hourly traffic variations for seven days for the March 2017 traffic survey.

The following points are noted in relation to peak hour traffic on the Windsor Bridge (Bridge Street over Hawkesbury River):

- The AM peak spreads over three hours between 6am and 9am, with traffic building up sharply between 7am and 8am when it reaches its peak;
- The PM peak also spreads over three hours between 3pm and 6pm, with traffic volumes gradually starting to build up around 3pm. The peak is reached at 5pm before it starts to decline sharply. The hour between 4pm and 5pm shows the predominant PM peak; and
- In the morning peak hour traffic direction is southbound towards Rouse Hill/Parramatta. This is mirrored in the afternoon peak with a similar volume of traffic heading northbound towards Wilberforce.

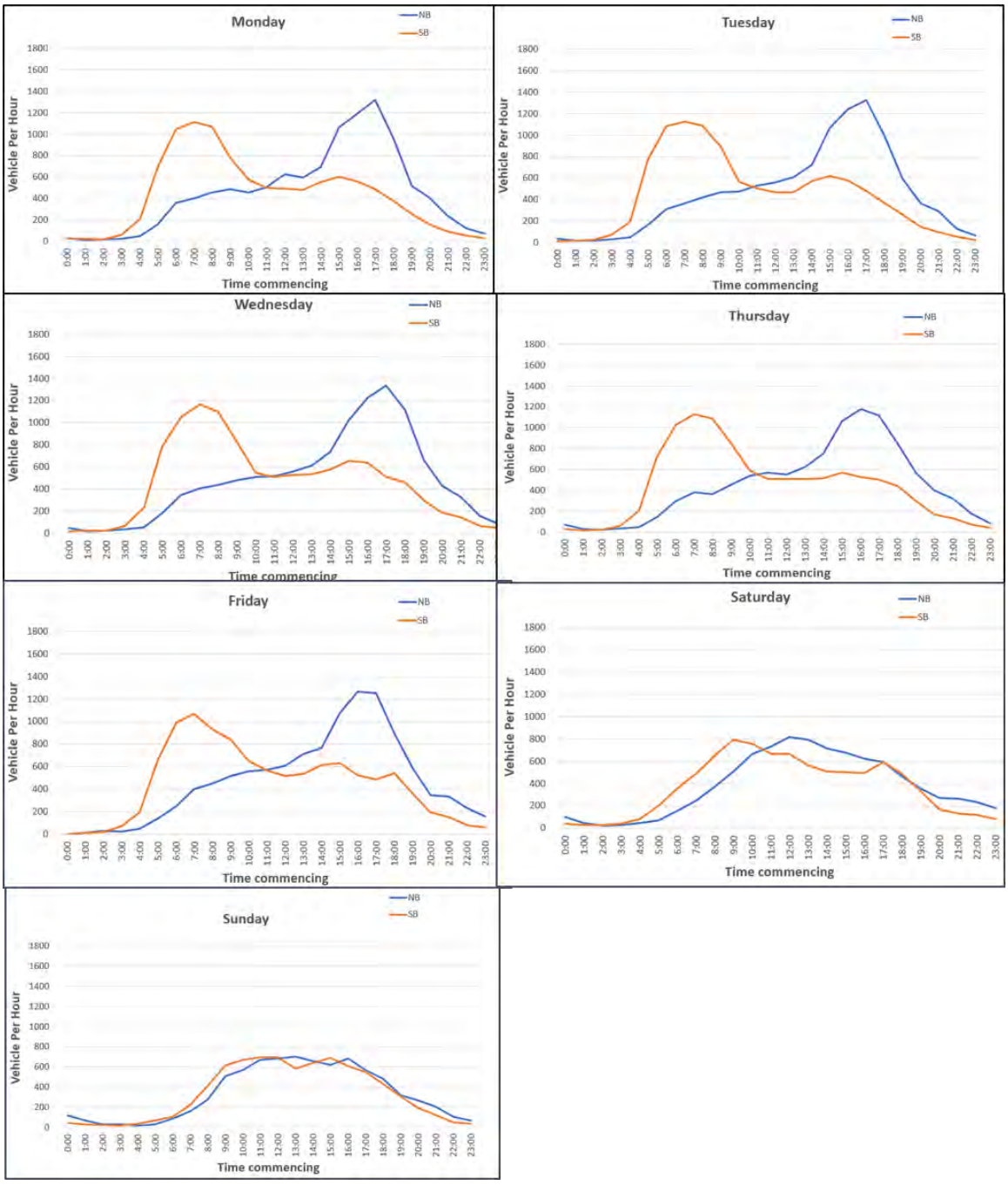


Figure 3-3 Hourly Traffic Profile – 7–day

3.2.4 Average Travel Speeds

The 2017 survey data shows that average travel speeds on Windsor Bridge are between 20 and 40 km/h; lower than the posted speed limit of 60 km/h.

In the morning peak the average travel speed on the bridge is 40 km/h in the northbound direction and 20 km/h in the southbound direction. In the afternoon peak, average travel speeds on the bridge are 40 km/h in the northbound direction and 30 km/h in the southbound direction.

3.2.5 Queue Lengths

Queue length surveys on at four key intersections within the study area were for AM peak two hours (7-9am) and PM peak two hours (4-6pm) in March 2017. Appendix A includes queue length survey results for AM and PM peak hour.

3.3 Peak Hour Traffic Volumes on Windsor Bridge

Table 3-3 shows the morning and afternoon peak hour traffic volumes on Windsor Bridge by travel direction in 2017.

Table 3-3 Peak Hour Traffic Volumes on Windsor Road in 2017

Road Section	AM Peak			PM Peak		
	NB	SB	Two-way	NB	SB	Two-way
Windsor Bridge (Bridge Street)	430 (29%)	1,050 (71%)	1,480 (100%)	1,220 (68%)	570 (32%)	1,790 (100%)

In 2017 Windsor Bridge carried about 1,480 and 1,790 vehicles (two-way) per hour in the AM and PM peak hours respectively. The AM peak data suggests substantial traffic (about 71 per cent) in the southbound direction. Conversely, the PM peak data suggests substantial traffic (about 68 per cent) in the northbound direction. The current peak hour directional traffic distribution on Windsor Bridge suggests typical 'tidal flow' distribution.

3.4 Capacity Assessment on Windsor Bridge

The notional traffic capacity of the Windsor Bridge was estimated using Austroads' *Guide to Traffic Management Part 3: Traffic Studies and Analysis.* Figure 3-4 shows hourly traffic distribution for the average weekday on the existing Windsor Bridge.

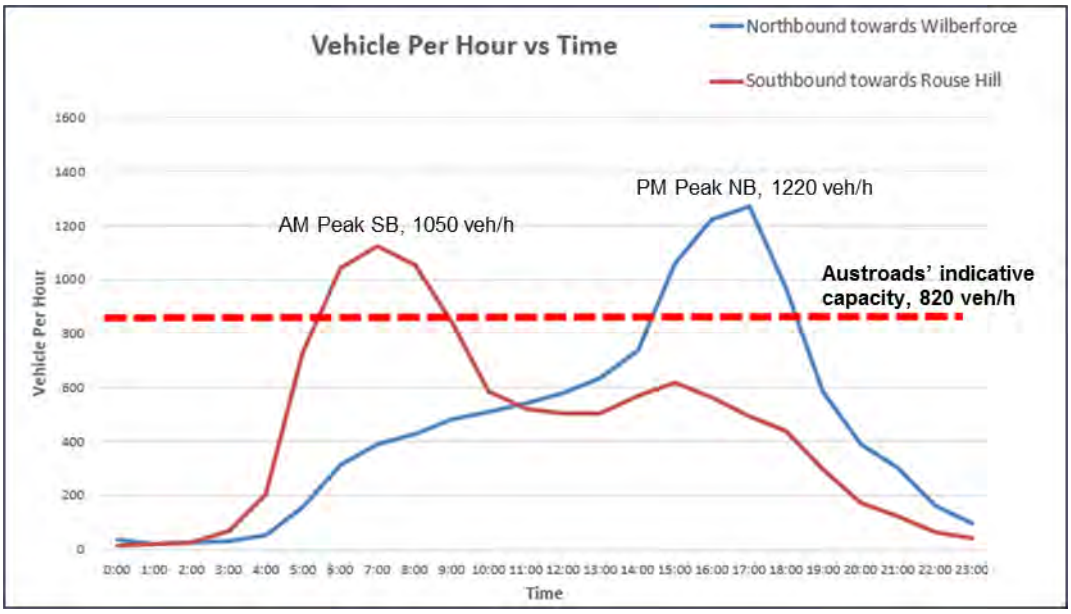


Figure 3-4 Hourly traffic volumes on Windsor Bridge, March 2017

The 2017 traffic data shows that during peak hour the bridge carries between 1,100 and 1,200 vehicles per hour in the peak direction. The Austroads' Guideline has suggested an indicative (notional) capacity of 820 vehicles per hour per lane as bridge traffic capacity. The bridge capacity of 820 vehicles per hour takes into account posted speed reductions for heavy vehicles and upstream and downstream intersection capacity.

The capacity analysis suggests that current traffic on Windsor Bridge exceeds the saturation traffic levels in both the morning (AM) and afternoon (PM) peak periods.

The existing condition analysis for the bridge also suggests the need for additional bridge capacity. Further capacity analysis is documented in Section 3.5 below.

3.5 Existing Intersection Level of Service

The capacity of the section of Bridge Street and Wilberforce Road between Court Street and Freemans Reach Road is strongly influenced by the operation of Windsor Bridge and adjoining key intersections.

Four intersections within the study area were analysed (using SIDRA, version 7 network) to determine the operating performance and level of service including:

- Wilberforce Road / Freemans Reach Road (sign controlled);
- Bridge Street / George Street (roundabout);
- Bridge Street / Macquarie Street (traffic signals); and
- Bridge Street / Court Street (sign controlled).

Figure 3-5 below shows the location of all 4 intersections in the study area.

Figure 3-5 Key intersections adjacent to Windsor Bridge

Figure 3-6 and Figure 3-7 showing counted 2017 turning volumes at above intersections for AM peak one hour (8-9am) and PM peak one hour (4-5pm).

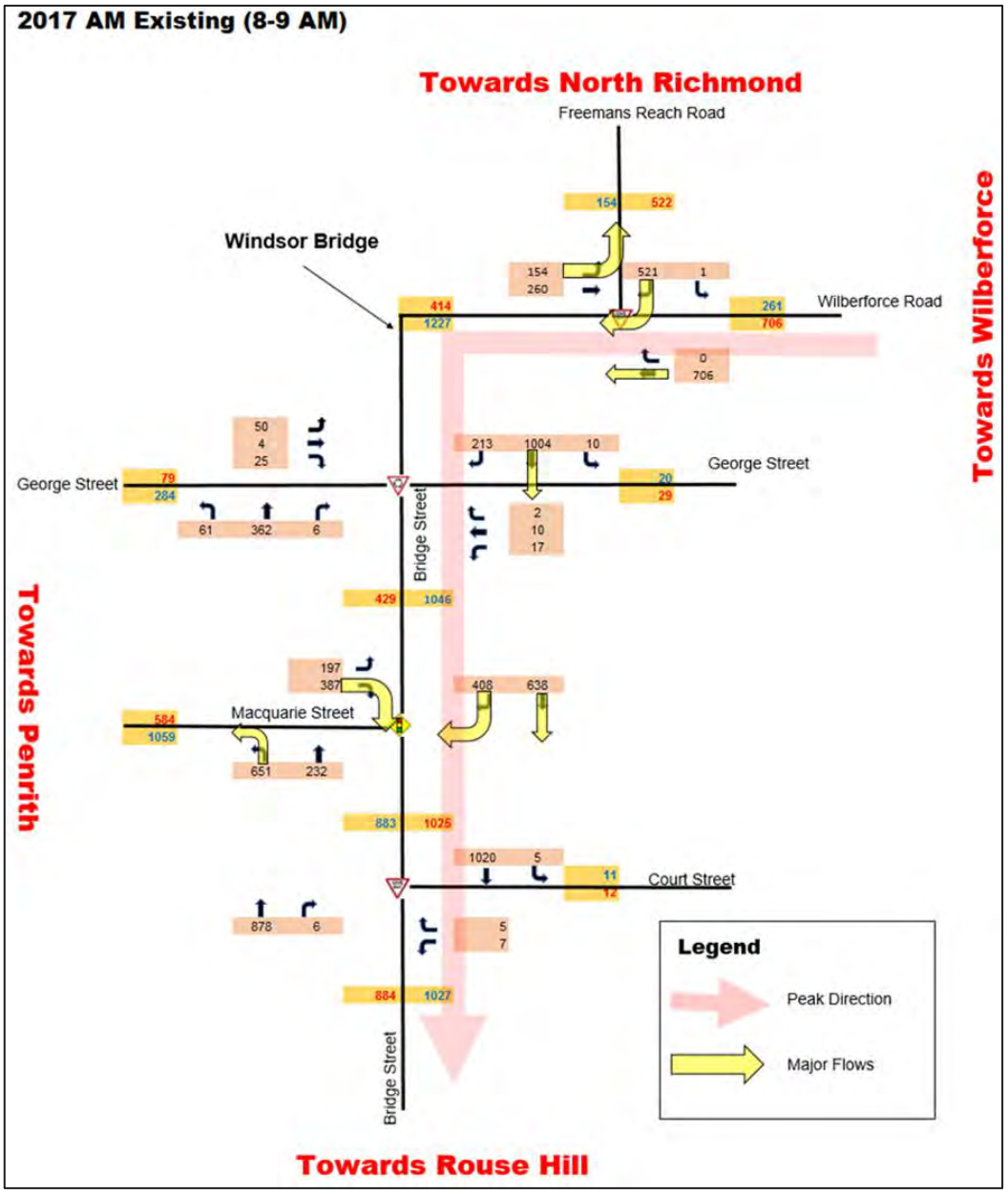


Figure 3-6 Existing Turning Volumes – 2017 AM Peak one hour (8-9am)

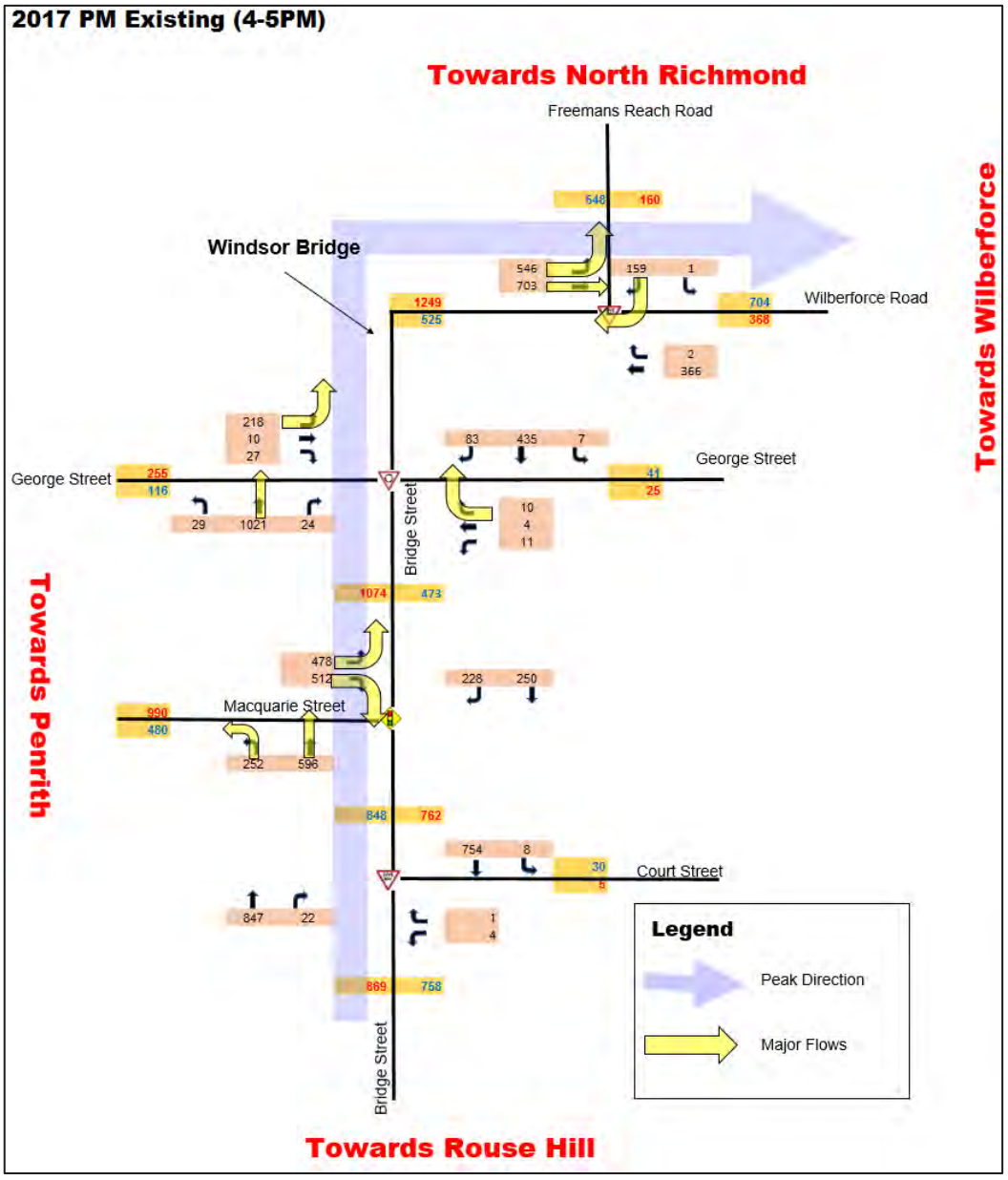


Figure 3-7 Existing Turning Volumes – 2017 PM Peak one hour (4-5pm)

The performance of an intersection is measured by the intersection average delay per vehicle, which in turns leads to a Level of Service measure for the intersection.

Table 3-4 below shows the Roads and Maritime standard level of service criteria for intersection operation.

Table 3-4 Level of Service Criteria for Intersections

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabout	Give Way & Stop Signs
A	<14	Good operation	Good operation
B	15 to 28	Good with acceptable delays & spare capacity	Acceptable delays & spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity & accident study required
E	57 to 70	At capacity; at signals, incidents will cause excessive delays Roundabouts require other control mode	At capacity, requires other control mode
F	>70	Unsatisfactory with excessive queuing	Unsatisfactory with excessive queuing

Level of Service (LoS) is reported in accordance with the Roads and Maritime guideline (*Traffic Modelling Guideline, Issue 1.0, RMS, February 21013*). It recommends that for priority intersections such as a roundabouts and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay. With these type of intersection controls (roundabout, Stops and Give way sign controls), some movements may experience high levels of delay while other movements may experience minimum delay. For a signalised intersection LoS criteria are related to the average intersection delay measured in seconds per vehicle.

Table 3-5 below shows the existing 2017 Level of Service at the four analysed intersections.

Table 3-5 Existing Level of Service in 2017

I-D	Intersection	Control	AM Peak		PM Peak	
			Delay (sec)	LoS	Delay (sec)	LoS
I-1	Wilberforce Road and Freemans Reach Road	Priority (1)	59	E	60	E
I-2	Bridge Street and George Street	Roundabout (1)	41	C	97	F
I-3	Bridge Street and Macquarie Street	Traffic Signals (2)	15	B	29	C
I-4	Bridge Street and Court Street	Priority (1)	37	C	22	B

Note: (1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay. (2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

The following points are noted for existing network performance:

- Two intersections north and south of Windsor Bridge currently operate at or over their capacity during peak hour. Wilberforce Road / Freemans Reach Road (sign controlled intersection) currently operates with Level of Service E in the AM and PM peaks (delays of 60 seconds). Bridge Street / George Street (roundabout) currently operates at Level of Service F in PM peak (delays of 97 seconds). The operational issues at both intersections adversely impact the traffic performance on Windsor Bridge during peak hours.
- The Bridge Street / Macquarie Street traffic signals operate with Level of Service between B to C (delays of 15 to 29 seconds) and Bridge Street / Court Street (sign controlled) intersection operates with Level of Service between B to C (delays of 22 to 37 seconds).

Appendix A documents detailed SIDRA results for existing 2017 AM and PM peak traffic conditions.

4 Future Traffic Performance of the Project

This section reports traffic growth for the study area road network. The future traffic growth analysis was undertaken using historical traffic growth and forecast traffic volumes obtained from Roads and Maritime's Strategic Traffic Forecasting Model (STFM, EMME model).

Future traffic growth has been reviewed and agreed with Roads and Maritime project team.

4.1 Historical Traffic Growth

The historical traffic growth on Windsor Bridge is estimated using 2012 and 2017 counts. The 2012 counts were sourced from Roads and Maritime's report '*Windsor Bridge Replacement Project, Traffic and Transport Working Paper – Working Paper 4, November 2012'.* The 2017 counts are sourced from the new traffic survey undertaken for this study.

Table 4-1 shows the comparison between 2012 and 2017 average daily traffic counts on Windsor Bridge. The last five year's traffic growth on Windsor Bridge between 2012 and 2017 is also shown.

Table 4-1 Comparison of Total Vehicles for 7-day Traffic – 2012 and 2017

Road Section	Average Daily Traffic			Traffic Growth per Annam
	March 2012	March 2017	Traffic Increase (5 years)	
Windsor Bridge (Bridge Street)	19,100	20,200	1,100 ▲	1.1% ▲

The data shows that between 2012 and 2017 (five year) traffic on Windsor Bridge has grown by approximately 1.1 per cent per annum from 19,100 vehicles per day in 2012 to 20,200 vehicles per day in 2017. Figure 4-1 shows the 24-hour traffic profiles on the Windsor Bridge based on 2012 and 2017 counts.

The 24-hour traffic profile on Windsor Bridge was found to be consistent between 2012 and 2017.

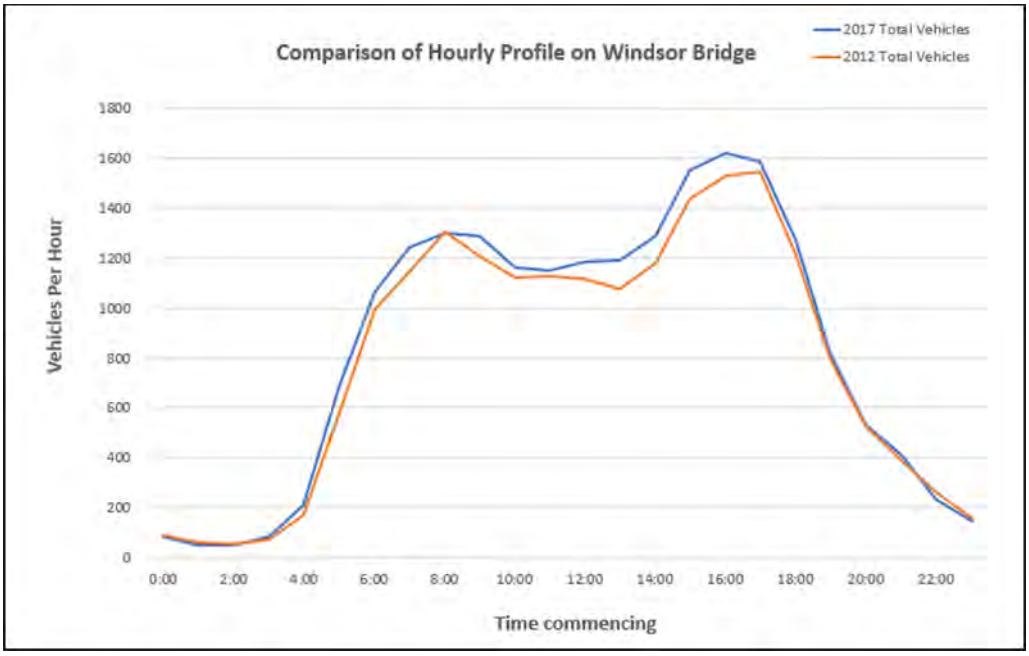


Figure 4-1 Comparison of Hourly Traffic Profile on Windsor Bridge – 2012 & 2017

4.2 Future Traffic Growth

Future traffic growth on Windsor Bridge, Bridge Street and adjoining roads within the study area will be influenced by the combination of passing (through) and local traffic growth. Future traffic growth in the study area was sourced from Roads and Maritime's Strategic Traffic Forecasting Model (STFM, EMME model). Roads and Maritime provided traffic forecasts at key roads for each time period up to 2026 and 2036. Both morning and afternoon peak hour traffic was assessed in the future years.

Future traffic growth assumptions have been reviewed and agreed with Roads and Maritime project team. Table 4-2 shows future traffic growth rates proposed for traffic modelling of the Windsor Bridge Replacement project.

Table 4-2 Proposed Growth Rates for Traffic Modelling Purposes

Road / Location	Growth Rate per Annum (%)		
	2016-2026	2026-2036	2016-2036 (average for 20 years period)
AM Peak			
Bridge Street (Windsor Bridge) and Macquarie Street	1.7%	1.0%	1.3%
George Street and Court Street	0.5%	0.5%	0.5%
PM Peak			
Bridge Street (Windsor Bridge) and Macquarie Street	1.7%	1.1%	1.4%
George Street and Court Street	0.3%	0.3%	0.3%

Table 4-2 indicates the following:

- The future traffic growth rate on Bridge Street (Windsor Bridge) and Macquarie Street will be 1.7 per cent per annum between 2016 and 2026, followed by 1.1 per cent per annum between 2026 and 2036.
- On George Street and Court Street, a lower traffic growth rate was suggested. Traffic volumes on George Street and Court Street would grow by between 0.3 per cent and 0.5 per cent between 2016 and 2036.

4.3 Traffic Implications of the 'Do Nothing' Option

The modelling outcomes from Roads and Maritime's Strategic Traffic Forecasting Model indicates traffic growth between 1.3 and 1.4 per cent per annum on Windsor Bridge until 2036.

Table 4-3 and Table 4-4 below show predicted Level of Service results for 2026 and 2036 traffic conditions for the 'do nothing' case.

Table 4-3 Forecast Level of Service in 2026 – 'Do Nothing'

I-D	Intersection	Control	AM Peak		PM Peak	
			Delay (sec)	LoS	Delay (sec)	LoS
I-1	Wilberforce Road and Freemans Reach Road	Priority (1)	583	F	97	F
I-2	Bridge Street and George Street	Roundabout (1)	49	D	351	F
I-3	Bridge Street and Macquarie Street	Traffic Signals (2)	18	B	153	F
I-4	Bridge Street and Court Street	Priority (1)	51	D	32	C

Note: (1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay. (2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

Table 4-4 Forecast Level of Service in 2036 – 'Do Nothing'

I-D	Intersection	Control	AM Peak		PM Peak	
			Delay (sec)	LoS	Delay (sec)	LoS
I-1	Wilberforce Road and Freemans Reach Road	Priority (1)	500+	F	123	F
I-2	Bridge Street and George Street	Roundabout (1)	63	E	783	F
I-3	Bridge Street and Macquarie Street	Traffic Signals (2)	19	B	376	F
I-4	Bridge Street and Court Street	Priority (1)	70	E	47	D

Note: (1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay. (2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

The model predicts Level of Service F either in the morning or afternoon peak hour at following intersections:

- Wilberforce Road / Freemans Reach Road (I-1);
- Bridge Street / George Street (I-2); and
- Bridge Street / George Street (I-3).

The future Level of Service analysis has found that if no action is taken to improve the traffic conditions on the Bridge Street and Wilberforce Road between Court Street and Freemans Reach Road, the following is likely to occur:

- Major congestion at a number of key intersections during peak periods by 2026 extending throughout a large part of the day
- Of the four key intersections analysed, three intersections showed Level of Service F (over capacity) in 2026 either in morning or afternoon peak periods. In 2036 three intersections showed Level of Service F in either the morning or afternoon peak periods
- Significant delaying and queuing would occur on Bridge Street extending to Wilberforce Road; and
- Road safety would deteriorate on Bridge Street, Wilberforce Road and associated intersections for all road users as traffic increases. The crash analysis indicted a need for safety improvement for both sections of Bridge Street and Wilberforce Road.

Appendix B includes detailed turning volumes for 2026 and 2036 and SIDRA Level of Service results for 2026 and 2036 'do nothing' scenario.

4.4 Future Traffic Volumes on new Windsor Bridge

Traffic volumes on new Windsor Bridge are reported for future years 2026 and 2036. Table 4-5 shows forecast average weekday daily traffic on new Windsor Bridge for 2026 and 2036.

Table 4-5 Estimated Average Weekday Traffic on Windsor Bridge for 2026 and 2036

	Existing			Forecast Average Weekday Traffic (vehicles)					
	2017 Counts			2026			2036		
	NB	SB	Two-way	NB	SB	Two-way	NB	SB	Two-way
Daily	10,800	10,800	21,600	12,500	12,500	25,000	14,000	14,000	28,000
AM peak	430	1,050	1,480	500	1,230	1,730	550	1,360	1,910
PM peak	1,220	570	1,790	1,420	660	2,080	1,590	730	2,320

In 2026, traffic on new Windsor Bridge is projected to be about 25,000 vehicles per day. By 2036, traffic is forecast to grow to about 28,000 vehicles per day.

In the morning, southbound peak traffic on the new Bridge is predicted to be about 1,200 vehicles per hour in 2026 and 1,400 vehicles per hour in 2036.

Similarly, in the afternoon, northbound peak traffic on the new Bridge is predicted to be about 1,400 vehicles per hour in 2026 and 1,600 vehicles per hour in 2036.

4.5 Future Traffic Performance of Concept Design

Future traffic performance of the Concept Design (see Figure 4-2) was assessed for year 2026 and 2036 traffic conditions.

Table 4-6 and Table 4-7 summarise forecast 2026 and 2036 Level of Service results for upgraded network conditions for the AM and PM peak hours, respectively.

Table 4-6 Forecast Level of Service in 2026 – Concept Design

I-D	Intersection	Control	AM Peak		PM Peak	
			Delay (sec)	LoS	Delay (sec)	LoS
I-1	Wilberforce Road and Freemans Reach Road	Roundabout (1)	15	B	17	B
I-2	Bridge Street and George Street	Traffic Signals (2)	17	B	62	E
I-3	Bridge Street and Macquarie Street	Traffic Signals (2)	21	B	56	E

Note: (1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay. (2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

Table 4-7 Forecast Level of Service in 2036 – Concept Design

I-D	Intersection	Control	AM Peak		PM Peak	
			Delay (sec)	LoS	Delay (sec)	LoS
I-1	Wilberforce Road and Freemans Reach Road	Roundabout (1)	17	B	17	B
I-2	Bridge Street and George Street	Traffic Signals (2)	25	B	169	F
I-3	Bridge Street and Macquarie Street	Traffic Signals (2)	25	B	99	F

Note: (1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay. (2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

In 2026, the upgraded network in Concept Design would provide adequate capacity and an acceptable Level of Service B for morning peak traffic condition.

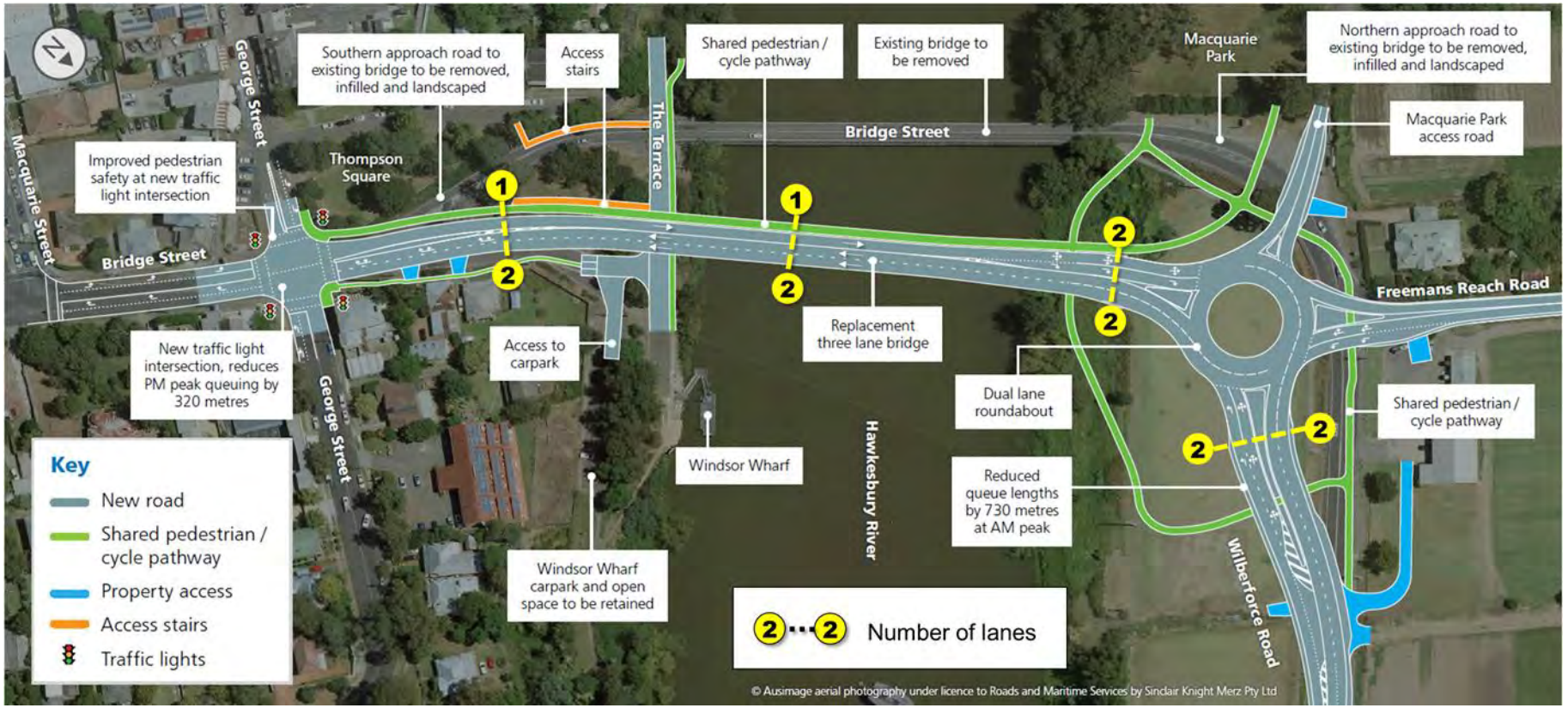
The traffic model predicted Level of Service B at Wilberforce Road / Freemans Reach Road (new roundabout), Bridge Street / George Street (new traffic signals) and Bridge Street / Macquarie Street traffic signals.

In the afternoon peak, the traffic model predicted Level of Service of E at Bridge Street / George Street traffic signals.

In 2036, the Concept Design would provide adequate capacity for the morning peak traffic condition. The traffic model predicted Level of Service B at Wilberforce Road / Freemans Reach Road (new roundabout), Bridge Street / Macquarie Street traffic signals and Bridge Street / George Street (new traffic signals).

In the afternoon peak, the traffic model predicted Level of Service F with delays of more than 169 seconds (2.8 minutes) at Bridge Street / George Street intersection and more than 99 seconds (1.8 minutes) at Bridge Street / Macquarie Street intersection.

Appendix C includes detailed forecast turning volumes and SIDRA Level of Service result for 2026 and 2036 for the Concept Design.



Source: Source: Windsor Bridge Replacement Project Update, December 2016, Roads and Maritime Services

Figure 4-2 Roads and Maritime's Concept Design

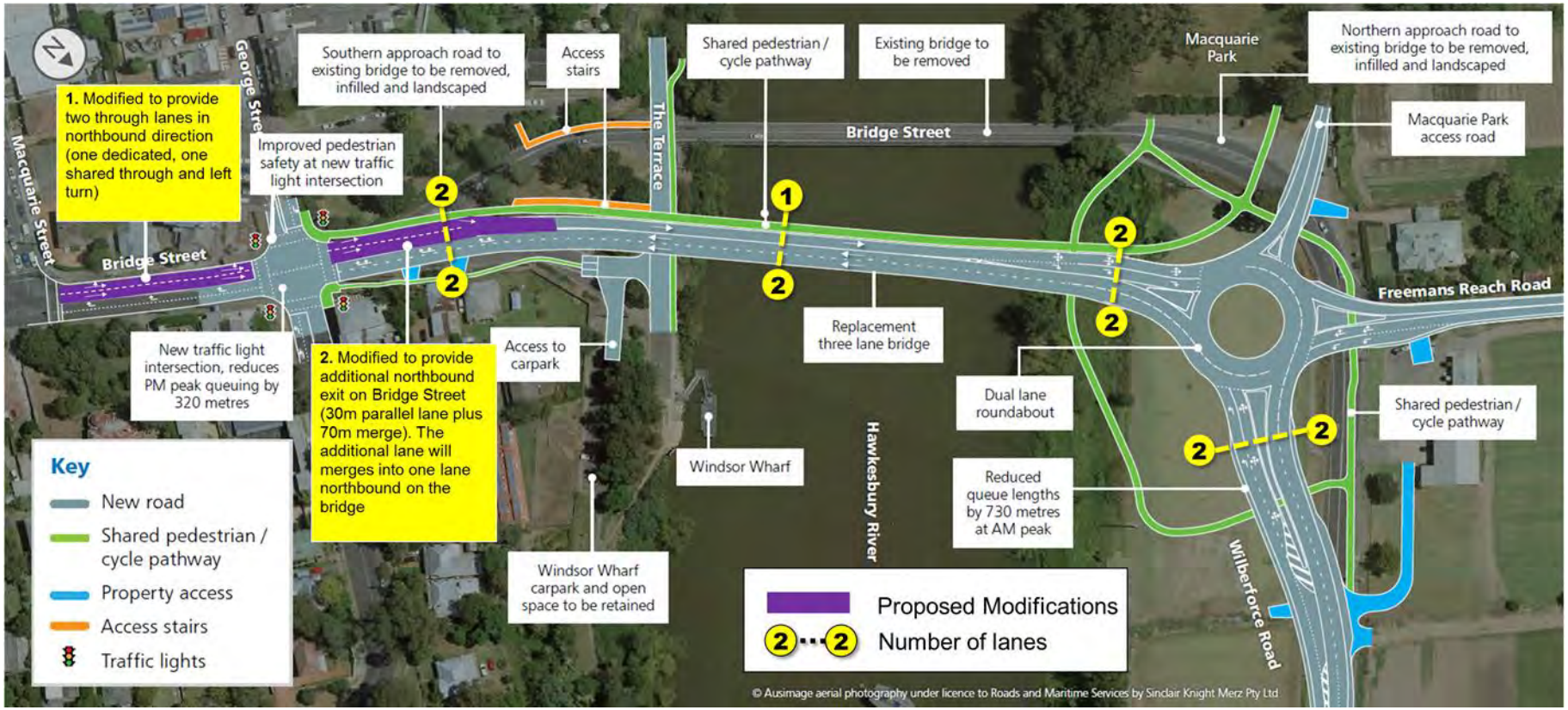
4.6 Proposed Modifications to the Concept Design (Modified Concept Design)

Roads and Maritime have proposed modifications to the Concept Design (referred as the Modified Concept Design) to increase traffic capacity in the northbound direction including:

1. Linemarking modification on the George Street southern approach at George Street / Bridge Street intersection to provide two through lanes in the northbound direction (one dedicated and one shared through and left turn); and
2. Provision of an additional short exit lane (30 metres parallel lane plus 70 metre merge) on the George Street northern approach (Windsor Bridge) at George Street / Bridge Street intersection. The additional lane merges into one lane northbound on Windsor Bridge.

To meet possible future demand, the modification allows for future tidal flow arrangements on Bridge Street. This would result in two lanes northbound across the bridge during the afternoon peak.

Figure 4-3 below shows indicative sketch of the Modified Concept Design (with modifications proposed to the Concept Design highlighted in purple).



Note: Proposed modifications to the Concept Design are highlighted in purple.

Figure 4-3 Modified Concept Design (Indicative Sketch)

4.7 Future Traffic Performance of the Modified Concept Design

The traffic performance of the Modified Concept Design was assessed for year 2026 and 2036 traffic conditions.

Table 4-8 and Table 4-9 summarise forecast 2026 and 2036 Level of Service results for the Modified Concept Design for the AM and PM peak hours, respectively. The forecast Level of Service result for the Concept Design is included for comparison.

Table 4-8 Forecast Level of Service in 2026 – Modified Concept Design

I-D	Intersection	Control	Concept Design				Modified Concept Design			
			AM Peak		PM Peak		AM Peak		PM Peak	
			Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
I-1	Wilberforce Road and Freemans Reach Road	Roundabout (1)	15	B	17	B	15	B	17	B
I-2	Bridge Street and George Street	Traffic Signals (2)	17	B	62	E	16	B	20	B
I-3	Bridge Street and Macquarie Street	Traffic Signals (2)	21	B	56	E	20	B	48	D

Note: (1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay. (2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

Table 4-9 Forecast Level of Service in 2036 – Modified Concept Design

I-D	Intersection	Control	Concept Design				Modified Concept Design			
			AM Peak		PM Peak		AM Peak		PM Peak	
			Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
I-1	Wilberforce Road and Freemans Reach Road	Roundabout (1)	17	B	17	B	17	B	19	B
I-2	Bridge Street and George Street	Traffic Signals (2)	25	B	169	F	24	B	30	C
I-3	Bridge Street and Macquarie Street	Traffic Signals (2)	25	B	99	F	23	B	83	F

Note: (1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay. (2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

The Level of Service results in Table 4-8 and Table 4-9 indicate that the proposed modifications to the Concept Design would reduce delays and improve Level of Service at Bridge Street / George Street and Bridge Street / Macquarie Street in the afternoon peak.

In the 2026 afternoon peak, the model predicted that proposed modifications would improve intersection performance at Bridge Street / George Street from Level of Service E with a delay of 62 seconds (Concept Design) to Level of Service B with a delay of 20 seconds (Modified Concept Design). At Bridge Street / Macquarie Street, the proposed modifications would improve intersection performance from Level of Service E with a delay of 56 seconds (Concept Design) to Level of Service D with a delay of 48 seconds (Modified Concept Design).

In the 2036 afternoon peak, the proposed modifications would improve intersection performance at Bridge Street / George Street from Level of Service F with a delay of more than 169 seconds (Concept Design) to Level of Service C with a delay of 30 seconds. At Bridge Street / Macquarie Street intersection, the proposed modification would reduce intersection delay from 99 seconds (Concept Design) to 83 seconds (Modified Concept Design). Travel delay could be improved by a future tidal flow arrangement.

Appendix D includes detailed SIDRA Level of Service result for 2026 and 2036 with Modified Concept Design.

5 Conclusions

Roads and Maritime proposes to replace the existing bridge over the Hawkesbury River at Windsor (known as 'Windsor Bridge'). The project includes a replacement bridge 35 metres north of the existing bridge, modifying the existing intersections and bridge approach roads to accommodate the new bridge location, and providing a shared pedestrian/cycle pathway for access to and across the replacement bridge. The replacement bridge would provide wider lanes and shoulders and greater sight distances in comparison to the existing bridge. Modifications would also be made to the bridge approach roads and existing intersections at Wilberforce Road / Freemans Reach Road, Bridge Street / George Street, Bridge Street / Count Street and Bridge Street / Macquarie Street. All of these factors would contribute to improvements in traffic capacity and safety.

Roads and Maritime has developed a Concept Design for the Windsor Bridge Replacement project between Wilberforce Road and Court Street, Windsor.

A road based traffic model was developed by Arcadis for the study area using SIDRA network version 7.

This report has been prepared to assess the network performance of the Concept Design and identify possible cost-effective improvements.

Currently (as of March 2017), Windsor Bridge carries approximately 21,600 vehicles per day. This includes approximately 2,400 heavy vehicles (more than 11 per cent of the total traffic). The current peak hour traffic volume on the Windsor Bridge is between 1,100 and 1,200 vehicles per hour in each travel direction. Capacity analysis suggests that current traffic demand on the Windsor Bridge (one lane in northbound and one lane in southbound) exceeds the saturation traffic levels in both morning (AM) and afternoon (PM) peak periods. Traffic modelling undertaken for existing condition has identified network operational issues at the following two intersections:

- Wilberforce Road / Freemans Reach Road (sign controlled); and
- Bridge Street / George Street (roundabout).

The Concept Design for the Windsor Bridge Replacement project involves a three lane bridge replacement of the existing Windsor Bridge, providing two lanes in the southbound direction and one lane in northbound direction, new traffic signals replacing the roundabout at Bridge Street / George Street, a new dual lane roundabout replacing priority control at Wilberforce Road / Freemans Reach Road and providing access to Macquarie Park via the western approach.

In year 2026, traffic on the new Windsor Bridge is predicted to be 25,000 vehicles per day. By 2036, traffic is forecast to grow to approximately 28,000 vehicles per day. In the morning, southbound peak traffic on the new bridge is predicted to be about 1,200 vehicles per hour in 2026 and 1,400 vehicles per hour in 2036.

Similarly, in the afternoon, northbound peak traffic on the new bridge is predicted to be 1,400 vehicles per hour in 2026 and 1,600 vehicles per hour in 2036.

Arcadis' modelling assessment on the Concept Design found that:

- The upgraded intersections would provide Level of Service B during morning peak traffic conditions in 2036; and
- In the afternoon peak, the traffic model suggests capacity constraints at both Bridge Street / George Street and Bridge Street / Macquarie Street traffic signals. The Level of Service F is predicted at Bridge Street / George Street and Bridge Street / Macquarie Street traffic signals. The afternoon peak modelling results suggest the need to increase capacity for the northbound traffic.

Two modifications to the Concept Design for Windsor Bridge Replacement are proposed as follows:

- Linemarking modification on the George Street southern approach at George Street / Bridge Street intersection to provide two through lanes in the northbound direction (one dedicated lane and one shared through and left turn lane); and
- Provision of an additional short exit lane (30 metres parallel lane plus 70 metre merge) on George Street northern approach (Windsor Bridge) at George Street / Bridge Street intersection. The additional lane merges into one lane northbound on Windsor Bridge.

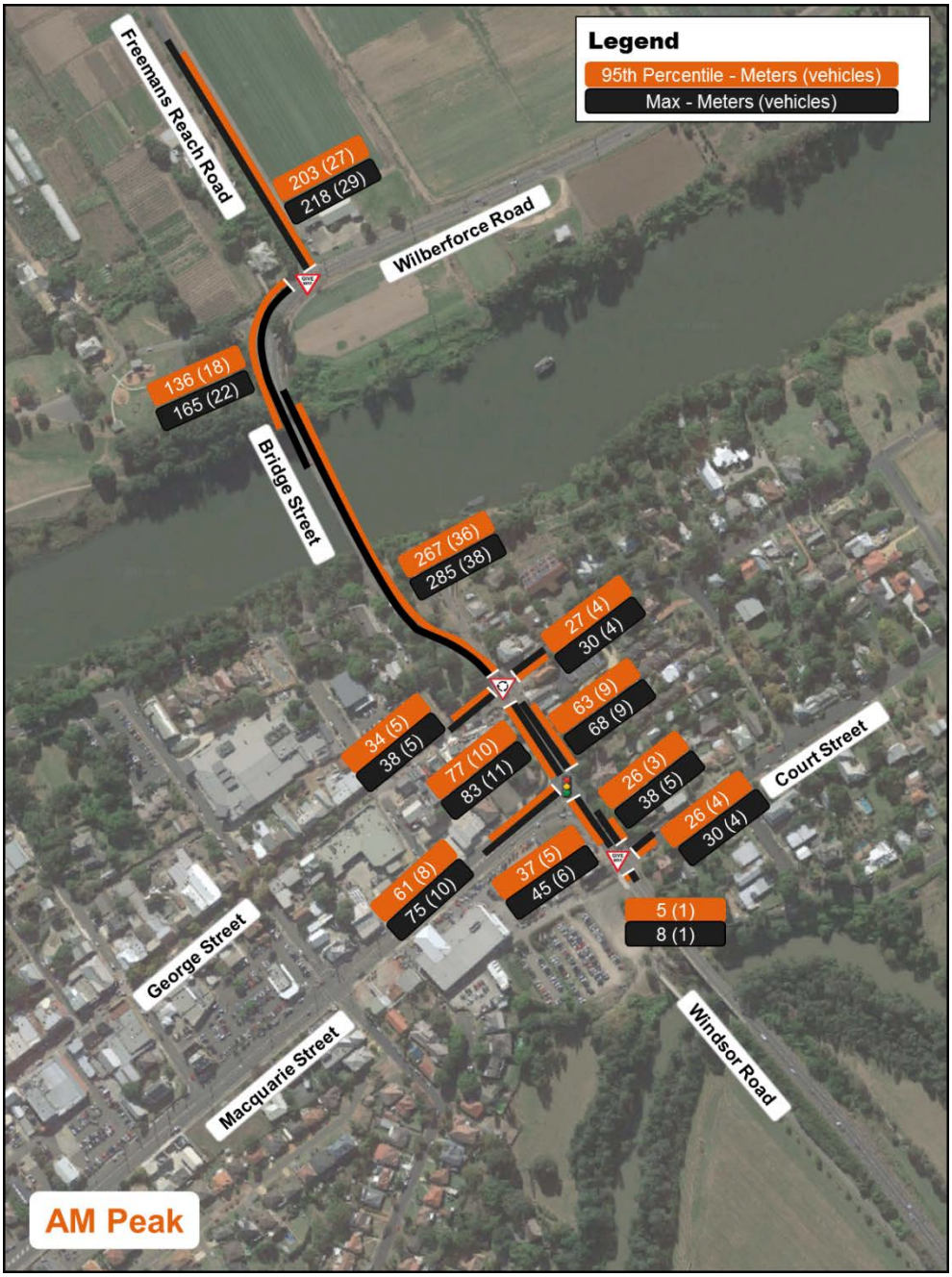
Arcadis' modelling assessment on the Modified Concept Design found that:

- The proposed modifications to the Concept Design (see Figure 4-3) would reduce delays and improve the Level of Service at Bridge Street / George Street and Bridge Street / Macquarie Street in the afternoon peak. The Level of Service B would be achieved in 2026;
- At Bridge Street / Macquarie Street, the intersection Level of Service would be improved to D in 2026; and
- In 2036, the proposed modifications would improve Level of Service to C at the Bridge Street / George Street intersection.

APPENDIX A Detailed SIDRA Analysis Results for 2017 Existing

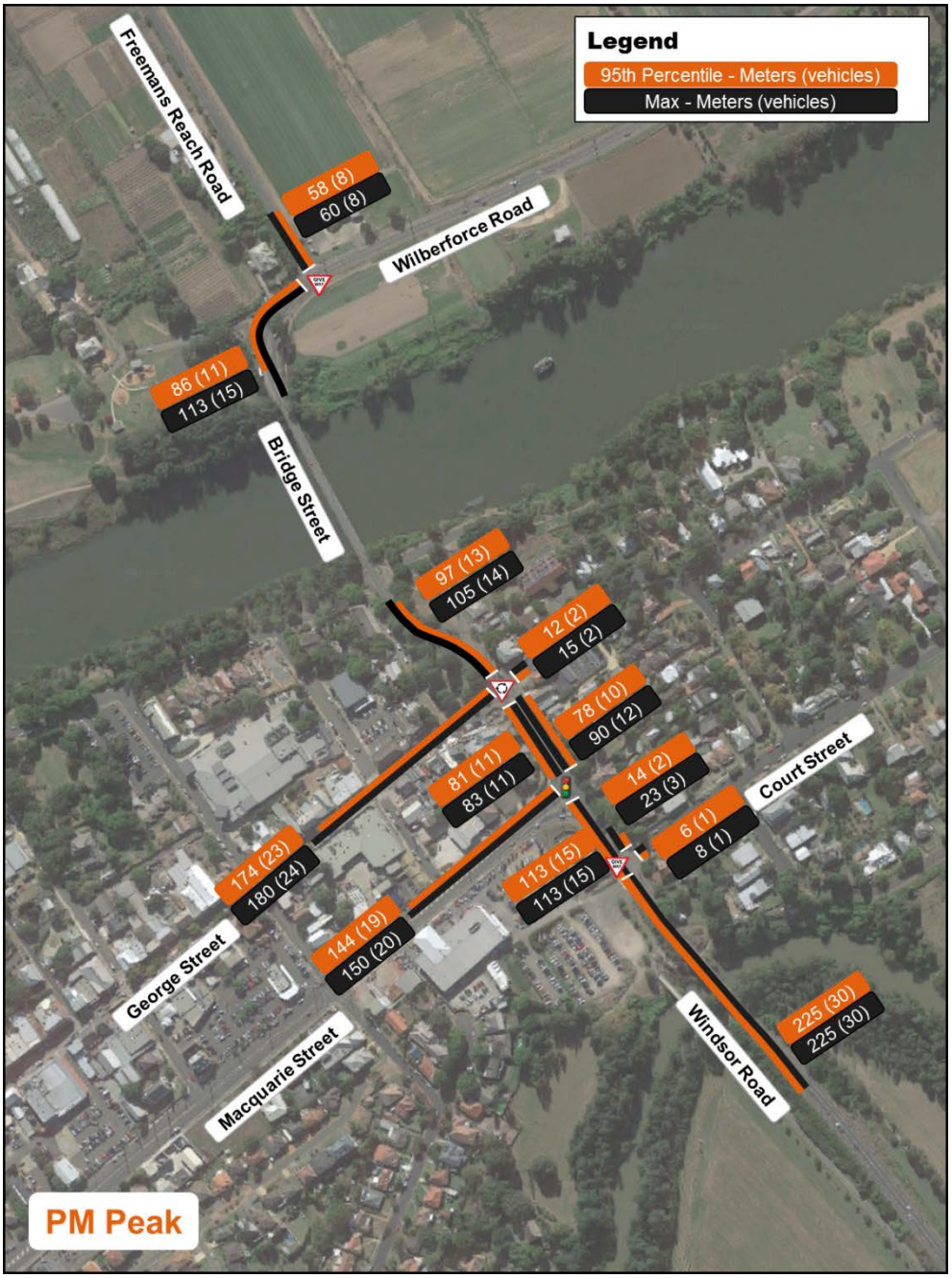
A.1 Existing Queue Length Survey Results (2017)

Figure A-1 and Figure A-2 shows existing (2017) queue length survey results in 95th percentile and maximum queue lengths in meters and number of vehicles for AM and PM peak hour.



Note: Surveyed queue length data was in number of vehicles. An average vehicle length of 7.5 metres was applied to convert vehicles to metres.

Figure A-1 Forecast Turning Volumes 2026 AM Peak (8-9AM)



Note: Surveyed queue length data was in number of vehicles. An average vehicle length of 7.5 metres was applied to convert vehicles to metres.

Figure A-2 Surveyed Queue Length (95th Percentile and Maximum) – PM Peak

A.2 Level of Service Results (SIDRA) – 2017 Existing

Wilberforce Road / Freemans Reach Road (sign control) - 2017 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Freemans Reach Road	59	E	170
East: Wilberforce Road	8	A	0
West: Bridge Street	3	A	0
Overall (1)	**59**	**E**	

Wilberforce Road / Freemans Reach Road (sign control) - 2017 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Freemans Reach Road	32	C	13
East: Wilberforce Road	60	E	7
West: Bridge Street	3	A	0
Overall (1)	**60**	**E**	

Bridge Street / George Street (roundabout) - 2017 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	6	A	298
East: George Street	41	C	12
South: Bridge Street	9	A	40
West: George Street	11	A	5
Overall (1)	**41**	**C**	

Bridge Street / George Street (roundabout) - 2017 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	6	A	40
East: George Street	13	A	2
South: Bridge Street	6	A	104
West: George Street	97	F	143
Overall (1)	**97**	**F**	

Bridge Street / Macquarie Street (traffic signals) - 2017 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	10	A	78
South: Bridge Street	6	A	27
West: Macquarie Street	37	C	54
Overall (2)	**15**	**B**	

Bridge Street / Macquarie Street (traffic signals) - 2017 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	19	B	74
South: Bridge Street	15	B	98
West: Macquarie Street	46	D	173
Overall (2)	**29**	**C**	

Bridge Street / Court Street (sign control) - 2017 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	4	A	0
East: Court Street	37	C	1
South: Bridge Street	22	B	3
Overall (1)	**37**	**C**	

Bridge Street / Court Street (sign control) - 2017 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	4	A	0
East: Court Street	22	B	0
South: Bridge Street	14	B	32
Overall (1)	**22**	**B**	

Note:
(1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay.
(2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

APPENDIX B Detailed SIDRA Analysis Results for 2026 and 2036 Do Nothing Scenario

B.1 2026 and 2036 Forecast Turning Volumes for the AM peak (8 to 9am) and PM peak (4 to 5pm)

Forecast 2026 AM (8-9 AM)

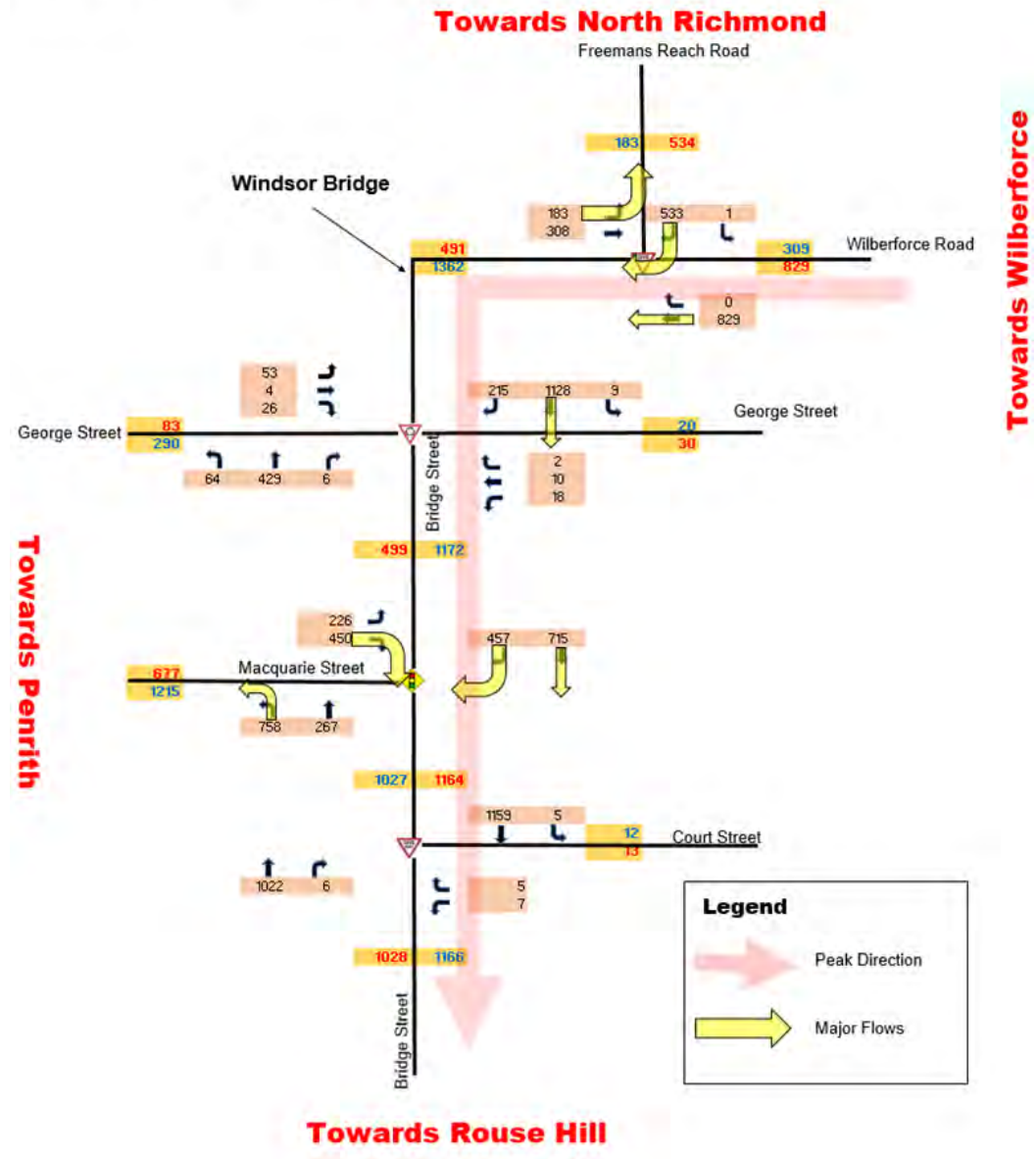


Figure B-1 Forecast Turning Volumes 2026 AM Peak (8-9AM)

Forecast 2026 PM (4-5 PM)

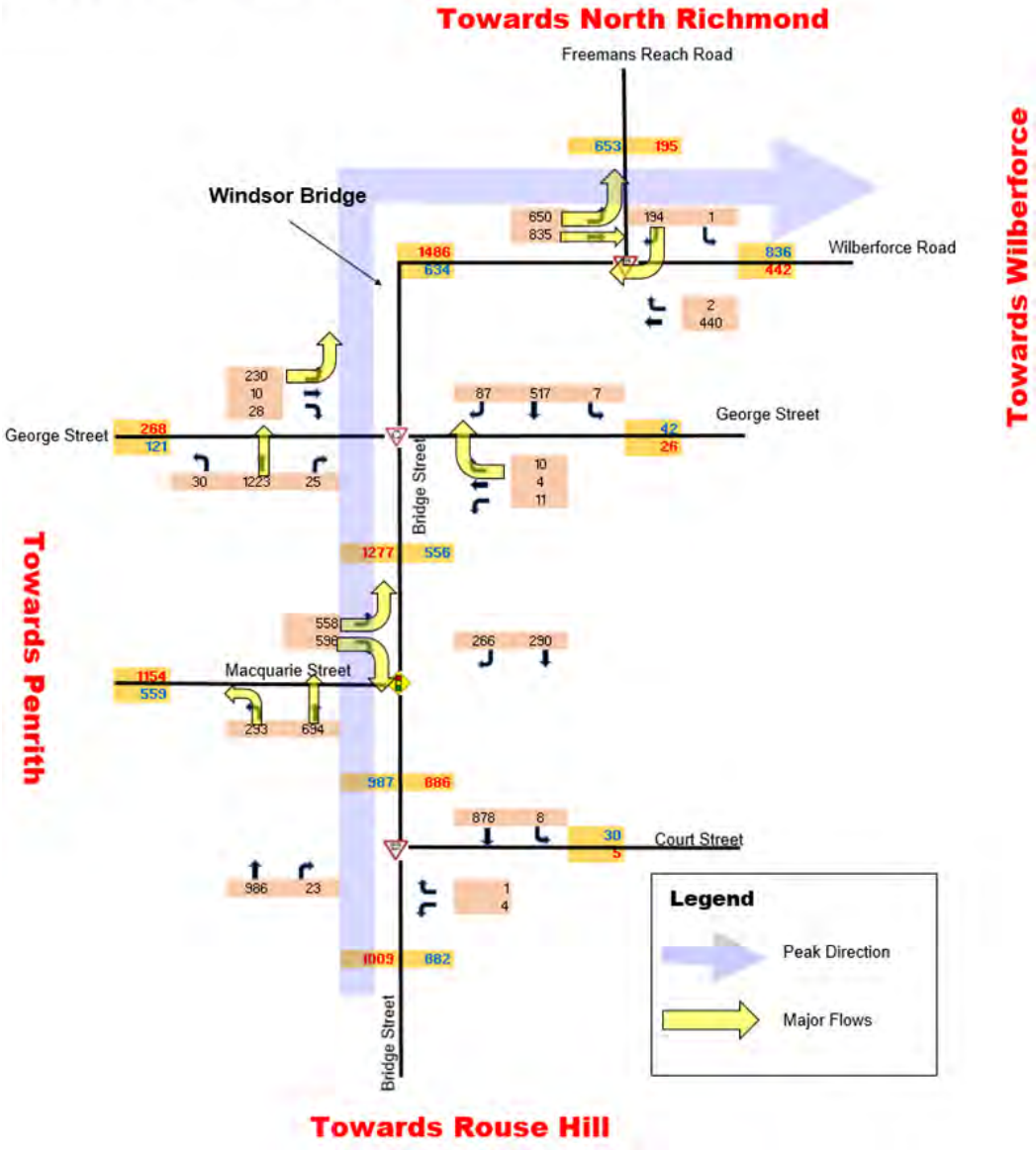


Figure B-2 Forecast Turning Volumes 2026 PM Peak (4-5PM)

Forecast 2036 AM (8-9 AM)

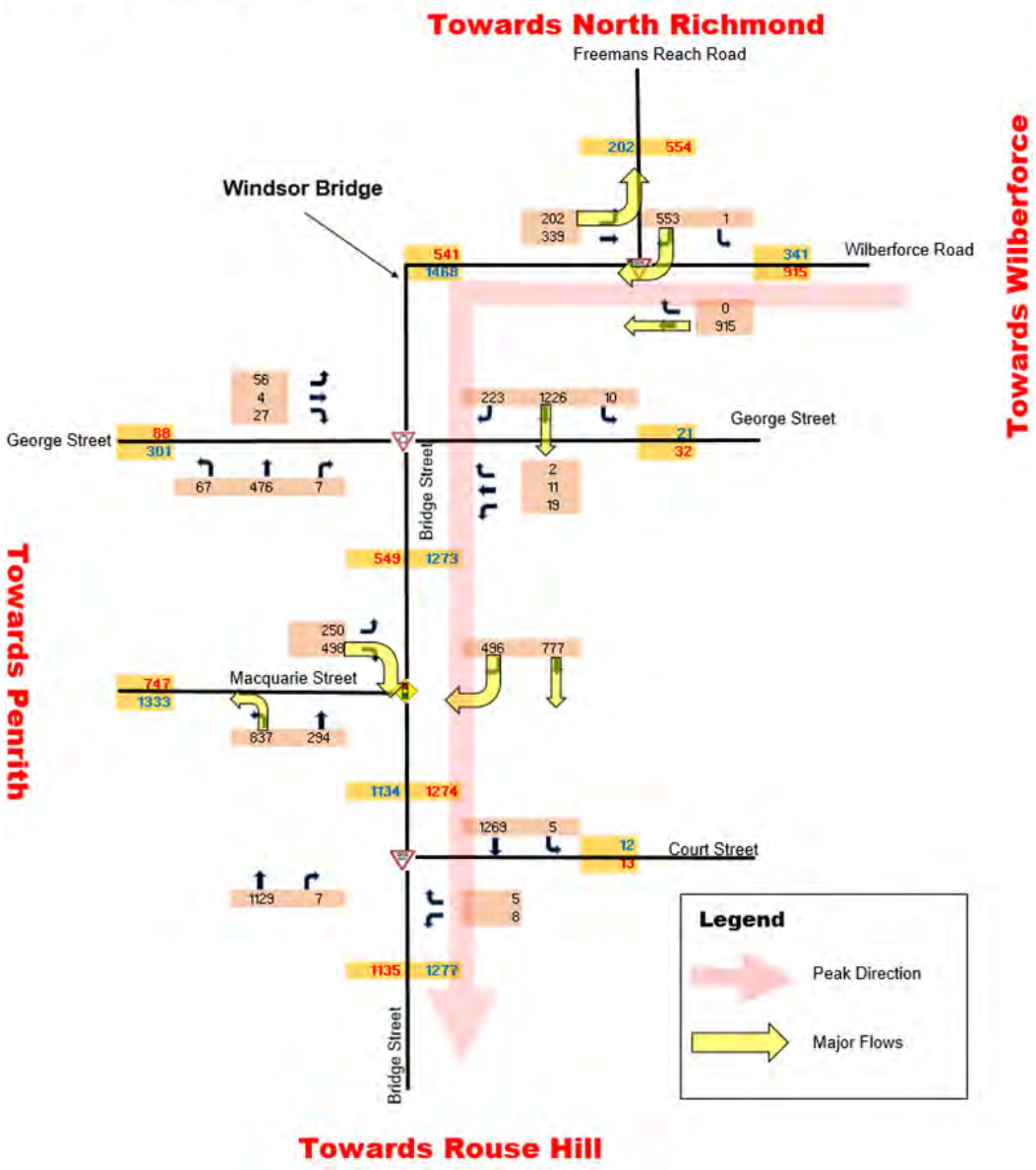


Figure B-3 Forecast Turning Volumes 2036 AM Peak (8-9AM)

Forecast 2036 PM (4-5 PM)

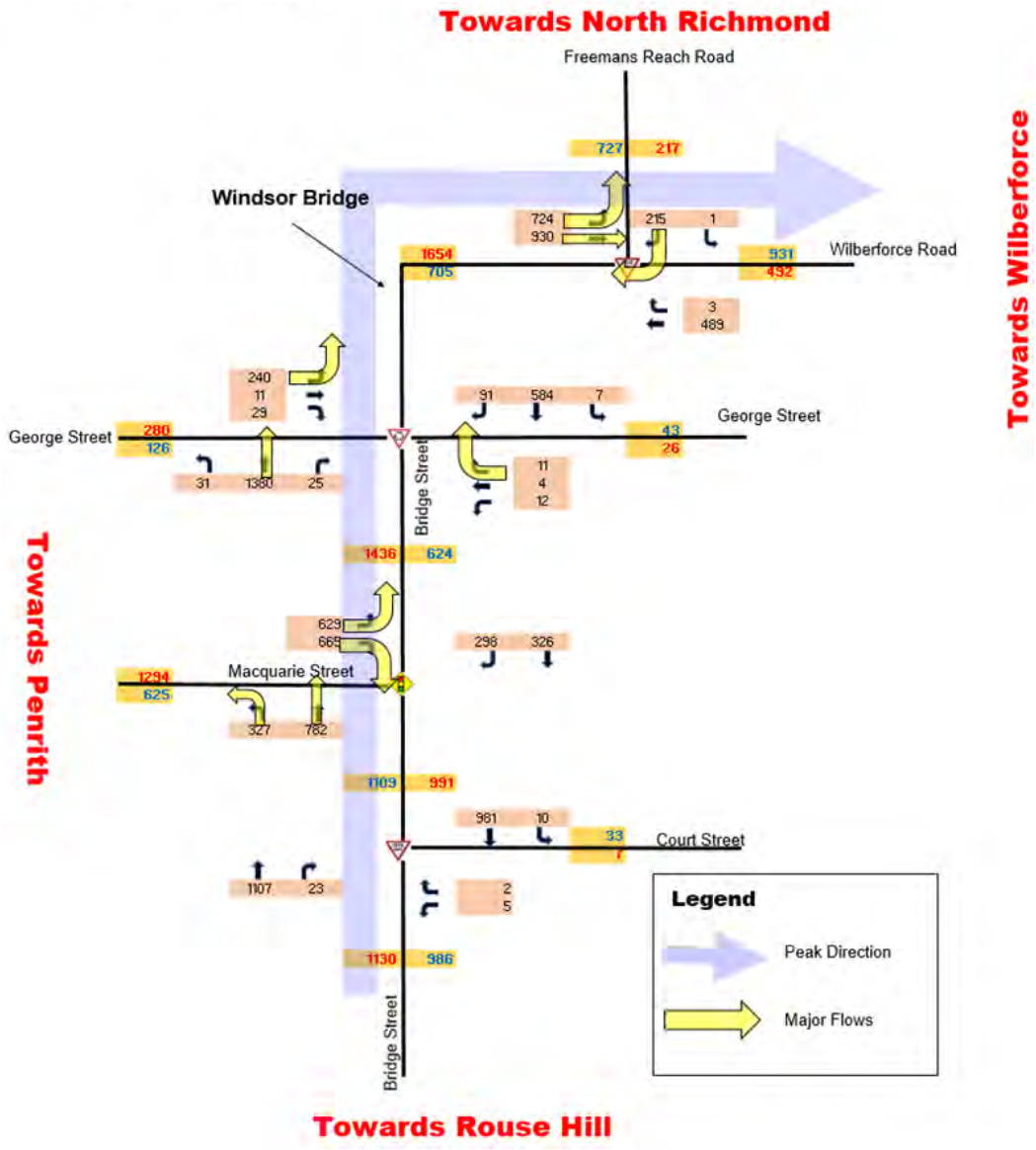


Figure B-4 Forecast Turning Volumes 2036 PM Peak (4-5PM)

B.2 Level of Service Results (SIDRA) – 2026 Do Nothing Scenario

Wilberforce Road / Freemans Reach Road (sign control) - 2026 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Freemans Reach Road	583	F	1200
East: Wilberforce Road	10	A	0
West: Bridge Street	3	A	0
Overall (1)	**583**	**F**	

Wilberforce Road / Freemans Reach Road (sign control) - 2026 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Freemans Reach Road	34	C	29
East: Wilberforce Road	97	F	15
West: Bridge Street	3	A	0
Overall (1)	**97**	**F**	

Bridge Street / George Street (roundabout) - 2026 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	6	A	294
East: George Street	49	D	13
South: Bridge Street	10	A	56
West: George Street	12	A	6
Overall (1)	**49**	**D**	

Bridge Street / George Street (roundabout) - 2026 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	6	A	56
East: George Street	15	B	2
South: Bridge Street	7	A	154
West: George Street	351	F	427
Overall (1)	**351**	**F**	

Bridge Street / Macquarie Street (traffic signals) - 2026 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	17	B	104
South: Bridge Street	9	A	50
West: Macquarie Street	34	C	65
Overall (2)	**18**	**B**	

Bridge Street / Macquarie Street (traffic signals) - 2026 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	25	B	84
South: Bridge Street	348	F	98
West: Macquarie Street	47	D	182
Overall (2)	**153**	**F**	

Bridge Street / Court Street (sign control) - 2026 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	4	A	0
East: Court Street	51	D	2
South: Bridge Street	26	B	4
Overall (1)	**51**	**D**	

Bridge Street / Court Street (sign control) - 2026 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	4	A	0
East: Court Street	32	C	0
South: Bridge Street	17	B	961
Overall (1)	**32**	**C**	

Note:
(1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay.
(2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

B.3 Level of Service Results (SIDRA) – 2036 Do Nothing Scenario

Wilberforce Road / Freemans Reach Road (sign control) - 2036 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres))
North: Freemans Reach Road	1228	F	2061
East: Wilberforce Road	11	A	0
West: Bridge Street	3	A	0
Overall (1)	**1228**	**F**	

Wilberforce Road / Freemans Reach Road (sign control) - 2036 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Freemans Reach Road	123	F	105
East: Wilberforce Road	104	F	186
West: Bridge Street	3	A	0
Overall (1)	**123**	**F**	

Bridge Street / George Street (roundabout) - 2036 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	7	A	350
East: George Street	63	E	15
South: Bridge Street	12	A	75
West: George Street	13	A	7
Overall (1)	**63**	**E**	

Bridge Street / George Street (roundabout) - 2036 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	6	A	74
East: George Street	16	B	3
South: Bridge Street	9	A	186
West: George Street	783	F	821
Overall (1)	**783**	**F**	

Bridge Street / Macquarie Street (traffic signals) - 2036 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	18	B	113
South: Bridge Street	9	A	56
West: Macquarie Street	37	C	79
Overall (2)	**19**	**B**	

Bridge Street / Macquarie Street (traffic signals) - 2036 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	27	B	97
South: Bridge Street	914	F	98
West: Macquarie Street	81	F	261
Overall (2)	**376**	**F**	

Bridge Street / Court Street (sign control) - 2036 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	4	A	0
East: Court Street	70	E	2
South: Bridge Street	31	C	7
Overall (1)	**70**	**E**	

Bridge Street / Court Street (sign control) - 2036 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	4	A	0
East: Court Street	47	D	1
South: Bridge Street	21	B	1793
Overall (1)	**47**	**D**	

Note:
(1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay.
(2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

APPENDIX C Detailed SIDRA Analysis Results for 2026 and 2036 with 'Concept Design'

C.1 2026 and 2036 Forecast Turning Volumes for the AM peak (8 to9am) and PM peak (4 to 5pm) with Concept Design

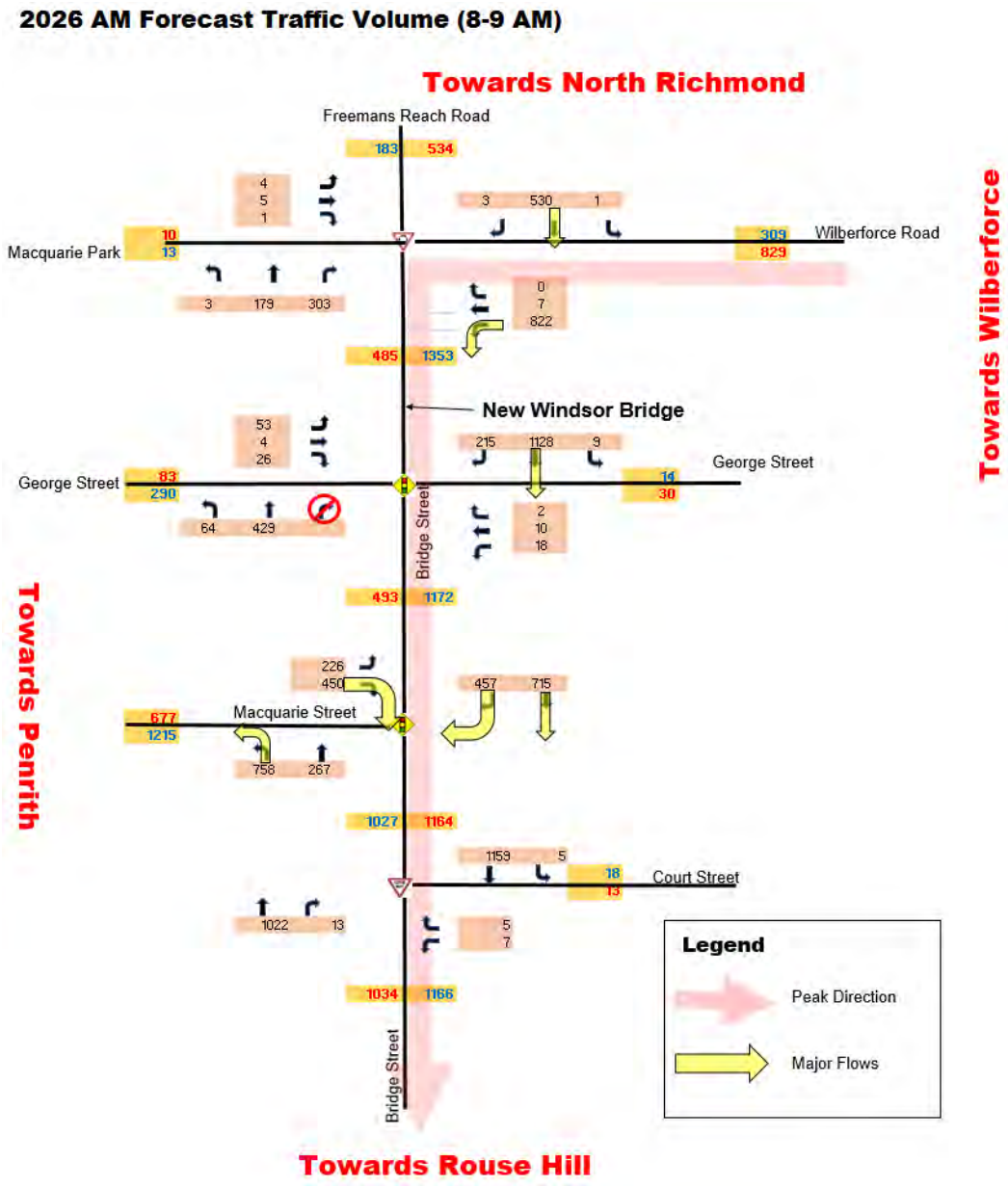


Figure C-1 Forecast Turning Volumes 2026 AM Peak (8-9AM) – with Concept Design

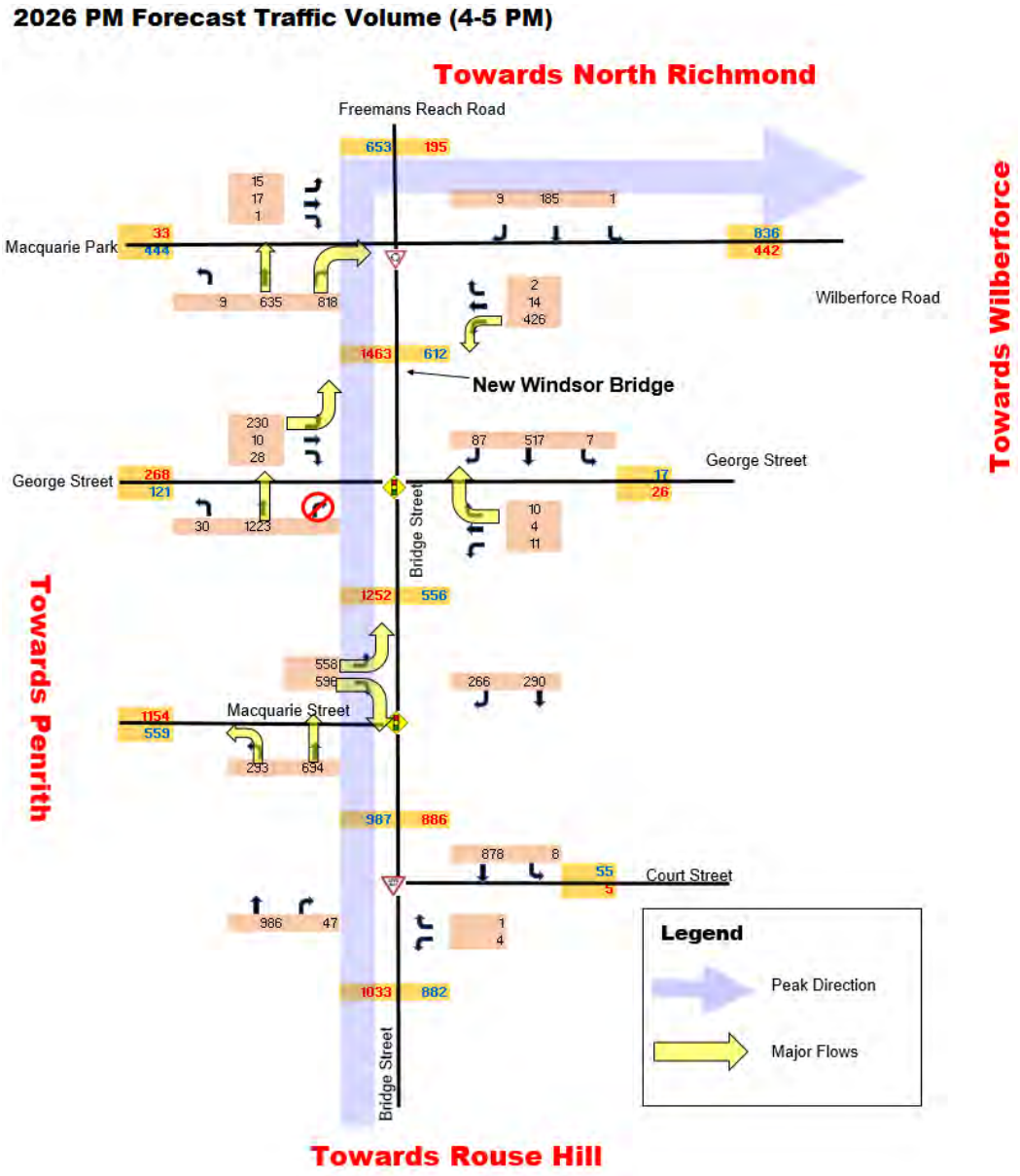


Figure C-2 Forecast Turning Volumes 2026 PM Peak (4-5PM) – with Concept Design

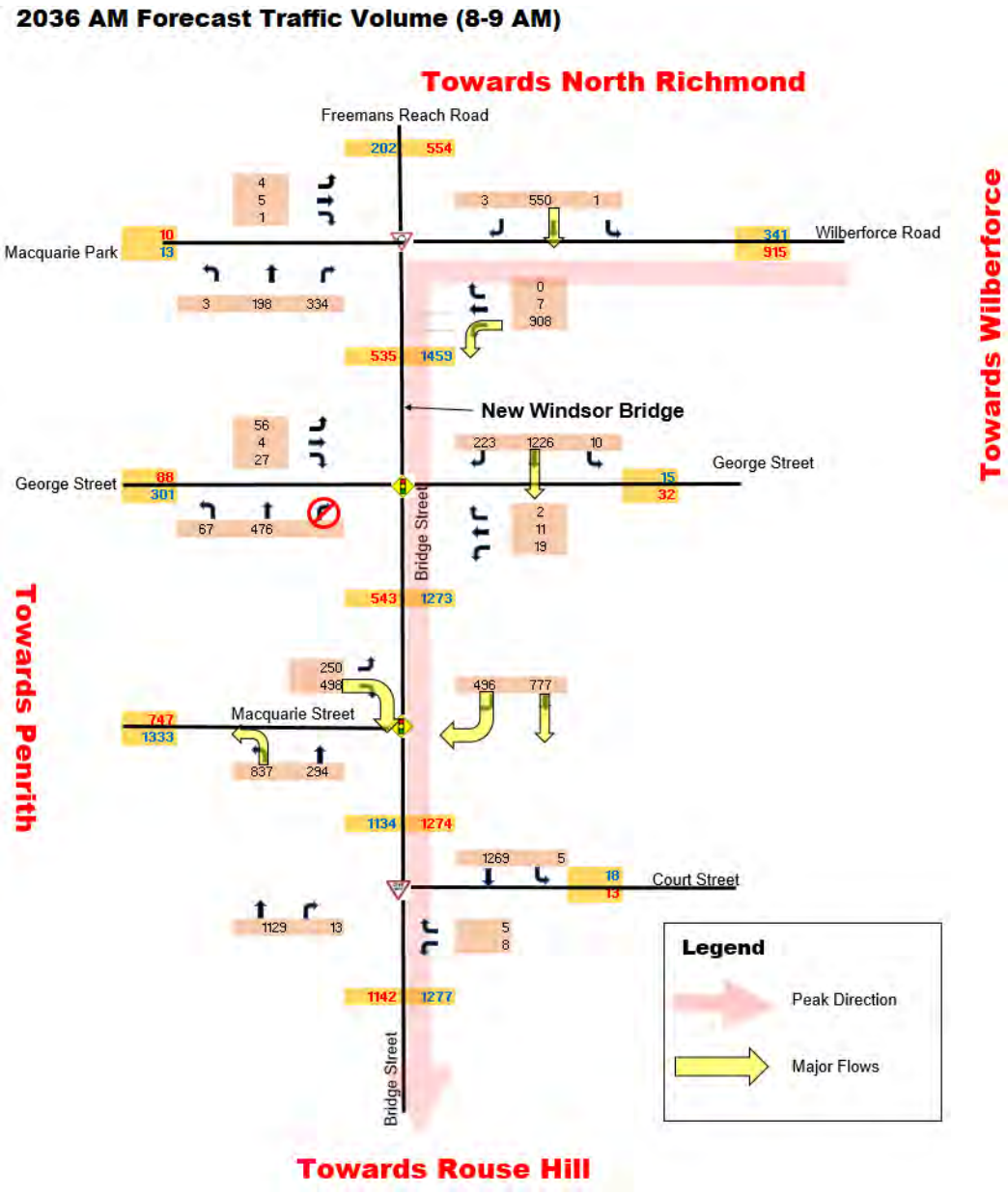


Figure C-3 Forecast Turning Volumes 2036 AM Peak (8-9AM) – with Concept Design

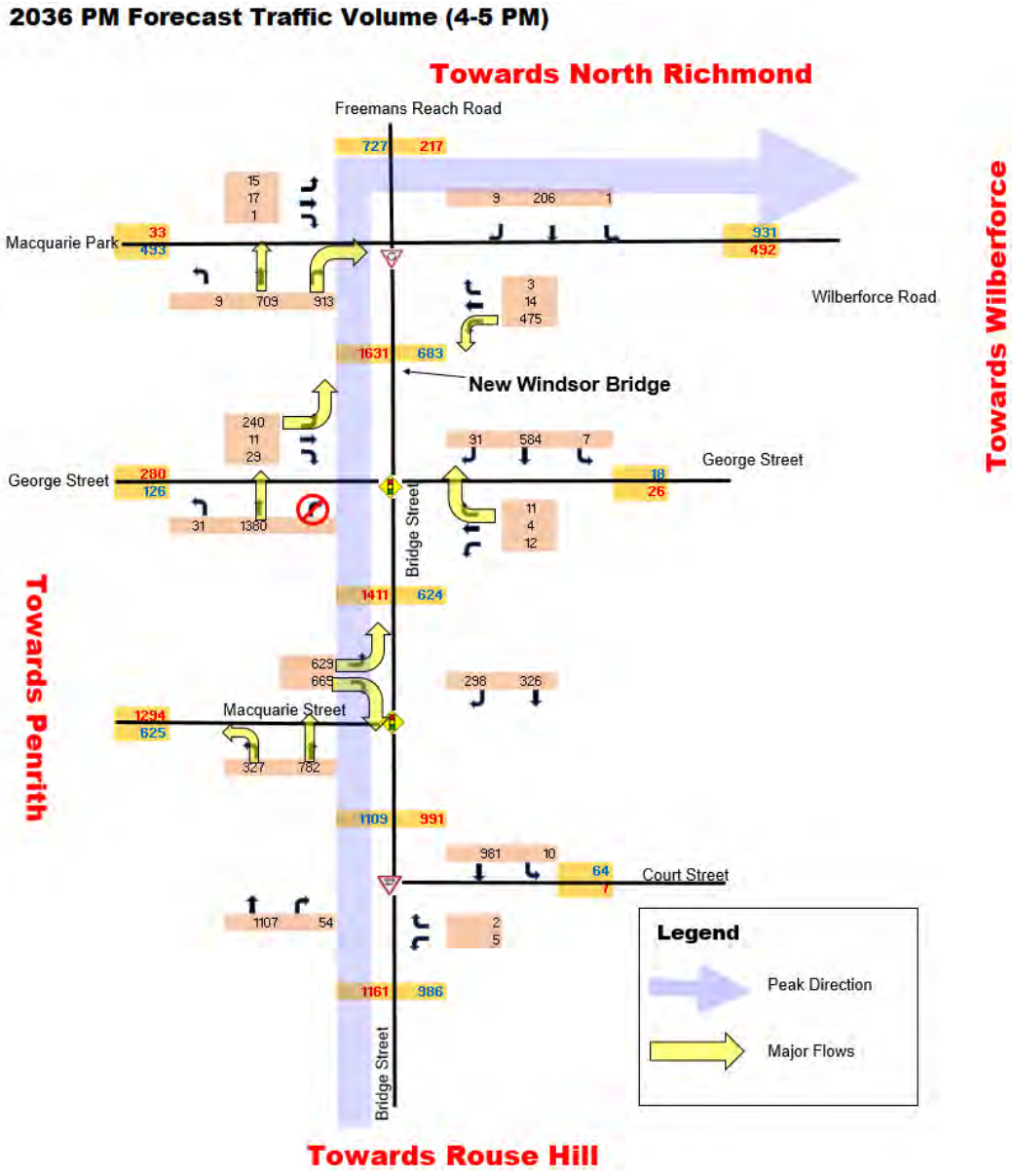


Figure C-4 Forecast Turning Volumes 2036 PM Peak (4-5PM) – with Concept Design

C.2 Predicted Queue Lengths in 2026 and 2036 with Concept Design

Figure C-5 to Figure C-6 show predicted queue lengths (95th percentile) at Wilberforce Road / Freemans Reach Road, Bridge Street / George Street and Bridge Street / Macquarie Street for 2026 AM and PM with Concept Design.

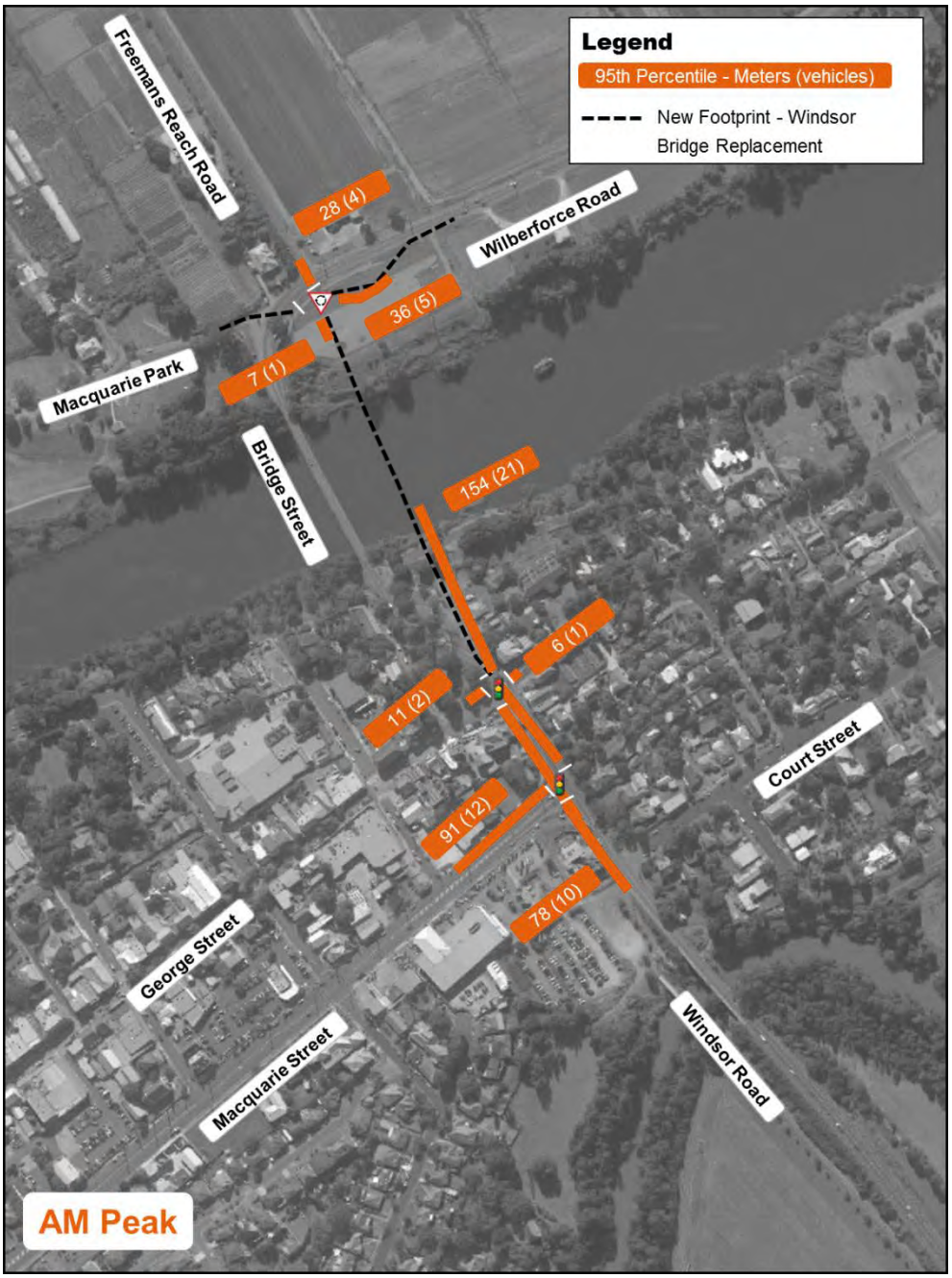


Figure C-5 Predicted 95th Percentile Queue Lengths in 2026 AM Peak with Concept Design

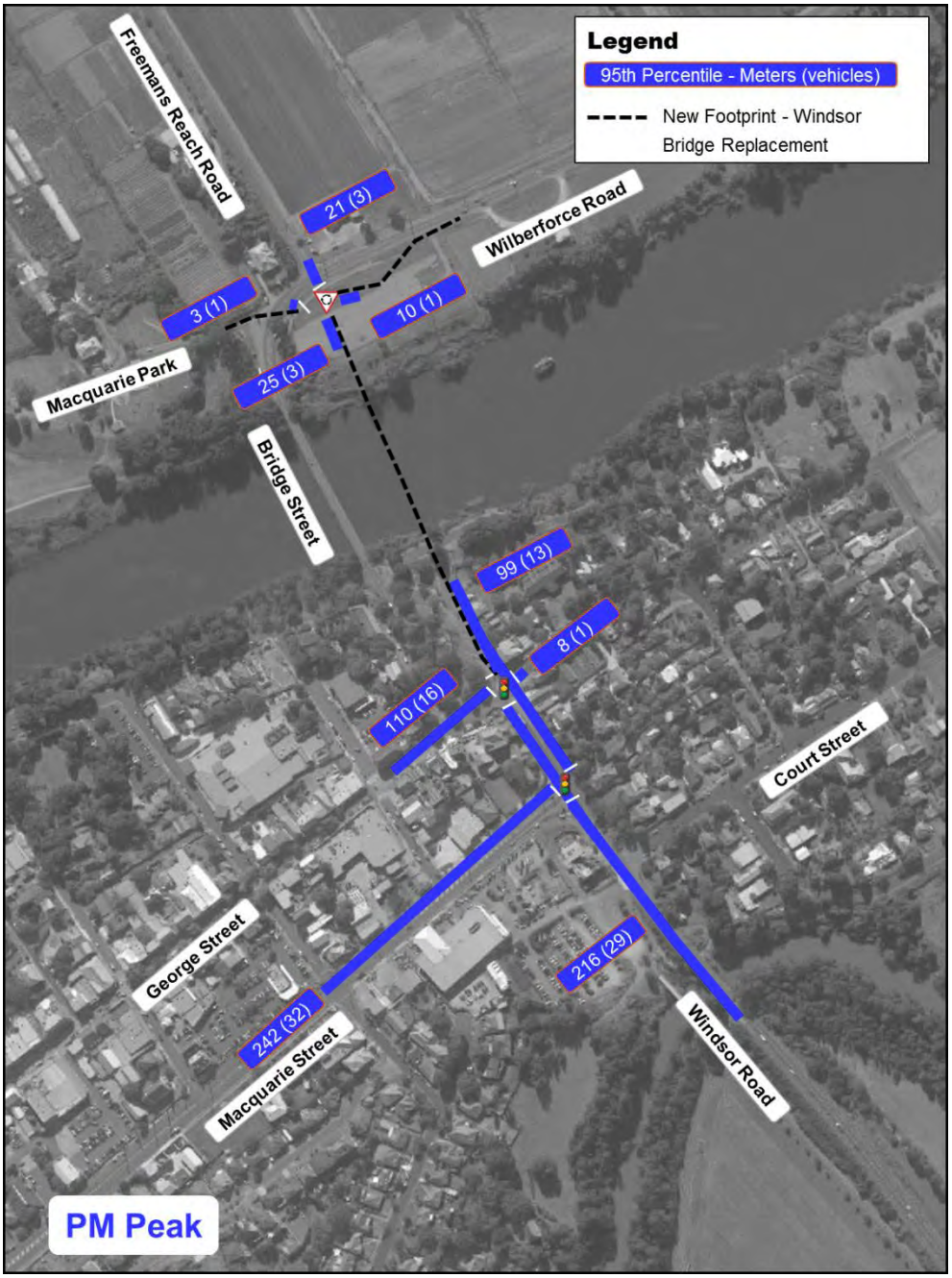


Figure C-6 Predicted 95th Percentile Queue Lengths in 2026 PM Peak with Concept Design

Figure C-7 to Figure C-8 show predicted queue lengths (95th percentile) at Wilberforce Road / Freemans Reach Road, Bridge Street / George Street and Bridge Street / Macquarie Street for 2036 AM and PM with Concept Design.

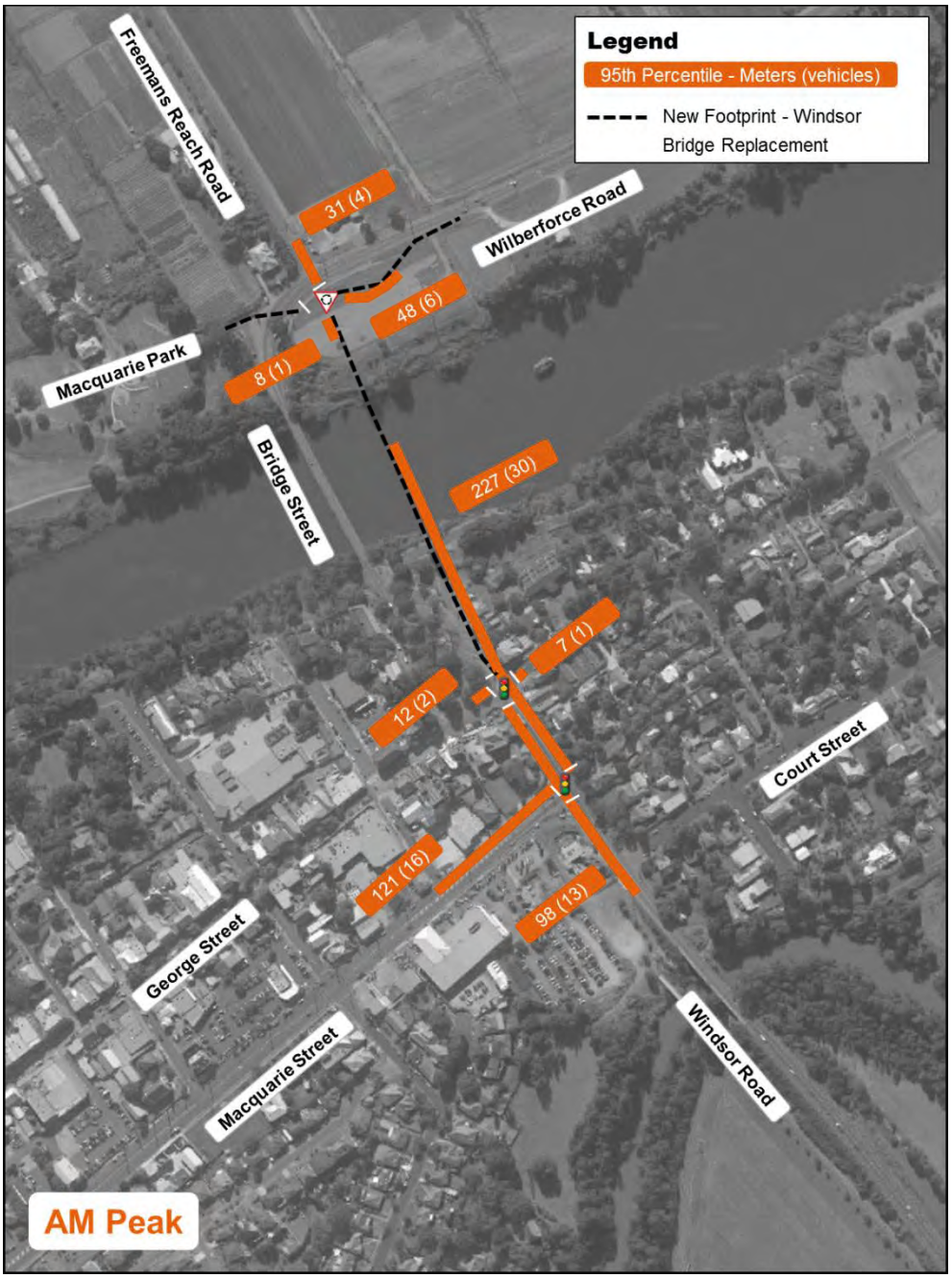


Figure C-7 Predicted 95th Percentile Queue Lengths in 2036 AM Peak with Concept Design

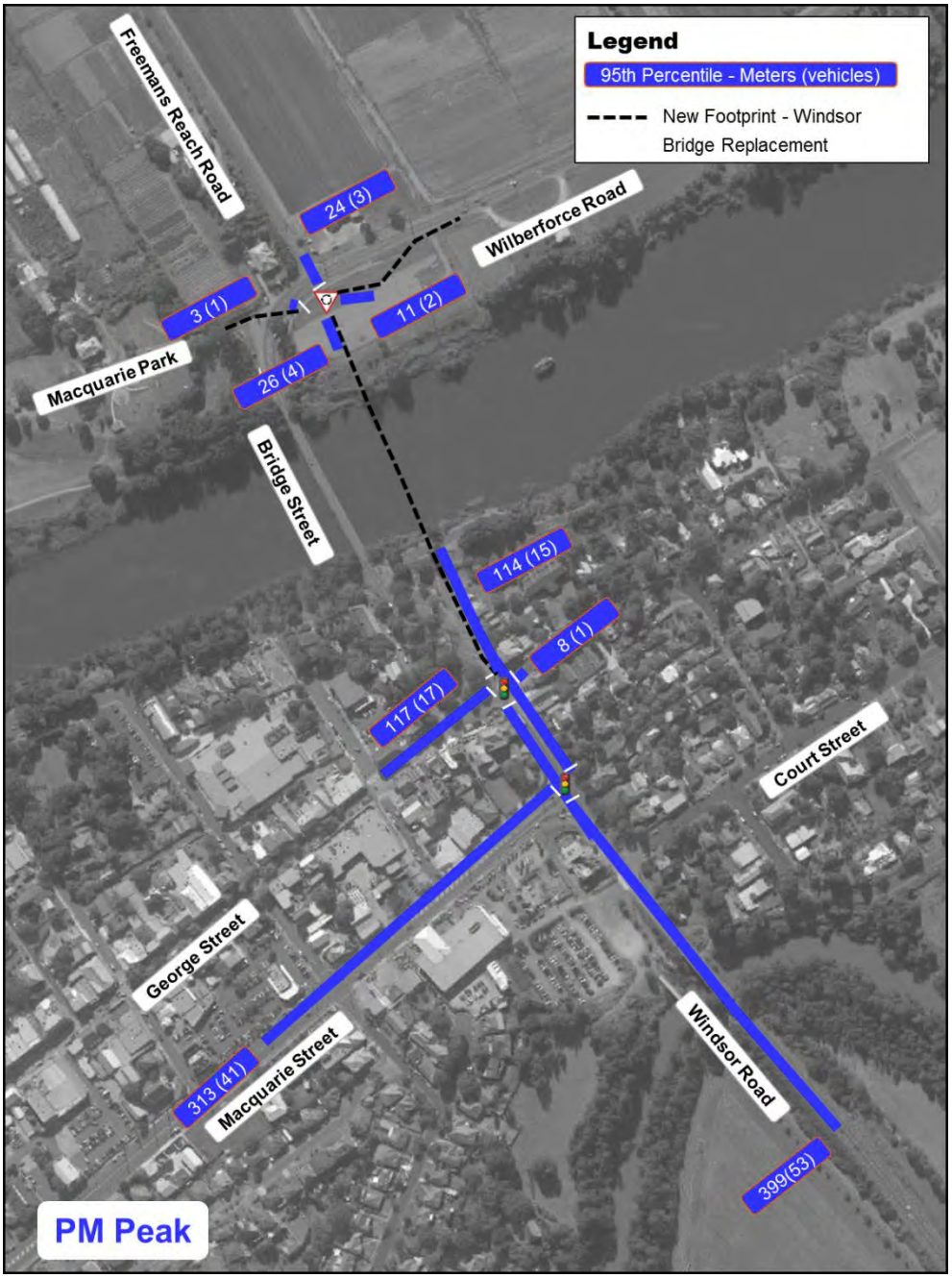


Figure C-8 Predicted 95th Percentile Queue Lengths in 2036 PM Peak with Concept Design

C.3 Level of Service Results (SIDRA) – 2026 with Concept Design

Wilberforce Road / Freemans Reach Road (new roundabout) - 2026 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Freemans Reach Road	11	A	28
East: Wilberforce Road	15	B	36
South: Bridge Street	10	A	7
West: Macquarie Park	11	A	0
Overall (1)	**15**	**B**	

Wilberforce Road / Freemans Reach Road (new roundabout) - 2026 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Freemans Reach Road	17	B	21
East: Wilberforce Road	11	A	10
South: Bridge Street	9	A	25
West: Macquarie Park	17	B	3
Overall (1)	**17**	**B**	

Bridge Street / George Street (new traffic signals) - 2026 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	12	A	154
East: George Street	47	D	6
South: Bridge Street	29	C	122
West: George Street	27	B	11
Overall (2)	**17**	**B**	

Bridge Street / George Street (new traffic signals) - 2026 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	14	A	99
East: George Street	74	F	8
South: Bridge Street	84	F	122
West: George Street	66	E	110
Overall (2)	**62**	**E**	

Bridge Street / Macquarie Street (traffic signals) - 2026 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	12	A	89
South: Bridge Street	15	B	78
West: Macquarie Street	44	D	91
Overall (2)	**21**	**B**	

Bridge Street / Macquarie Street (traffic signals) - 2026 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	35	C	122
South: Bridge Street	75	F	216
West: Macquarie Street	50	D	242
Overall (2)	**56**	**D**	

Note:
(1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay.
(2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

C.4 Level of Service Results (SIDRA) – 2036 with Concept Design

Wilberforce Road / Freemans Reach Road (new roundabout) - 2036 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Freemans Reach Road	11	A	31
East: Wilberforce Road	17	B	48
South: Bridge Street	10	A	8
West: Macquarie Park	11	A	0
Overall (1)	**17**	**B**	

Wilberforce Road / Freemans Reach Road (new roundabout) - 2036 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Freemans Reach Road	17	B	24
East: Wilberforce Road	11	A	11
South: Bridge Street	9	A	26
West: Macquarie Park	17	B	3
Overall (1)	**17**	**B**	

Bridge Street / George Street (new traffic signals) - 2036 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	16	B	227
East: George Street	47	D	7
South: Bridge Street	46	D	122
West: George Street	28	B	12
Overall (2)	**25**	**B**	

Bridge Street / George Street (new traffic signals) - 2036 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	13	A	114
East: George Street	75	F	8
South: Bridge Street	268	F	122
West: George Street	67	E	117
Overall (2)	**169**	**F**	

Bridge Street / Macquarie Street (traffic signals) - 2036 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	12	A	107
South: Bridge Street	19	B	98
West: Macquarie Street	56	D	121
Overall (2)	**25**	**B**	

Bridge Street / Macquarie Street (traffic signals) - 2036 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	37	C	122
South: Bridge Street	181	F	399
West: Macquarie Street	58	E	313
Overall (2)	**99**	**F**	

Note:
(1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay.
(2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

APPENDIX D Detailed SIDRA Analysis Results for 2026 and 2036 with 'Modified Concept Design'

D.1 Predicted Queue Lengths in 2026 and 2036 with Modified Concept Design

Figure D-1 to Figure D-2 show predicted queue lengths (95th percentile) at Wilberforce Road / Freemans Reach Road, Bridge Street / George Street and Bridge Street / Macquarie Street for 2026 AM and PM with Modified Concept Design.

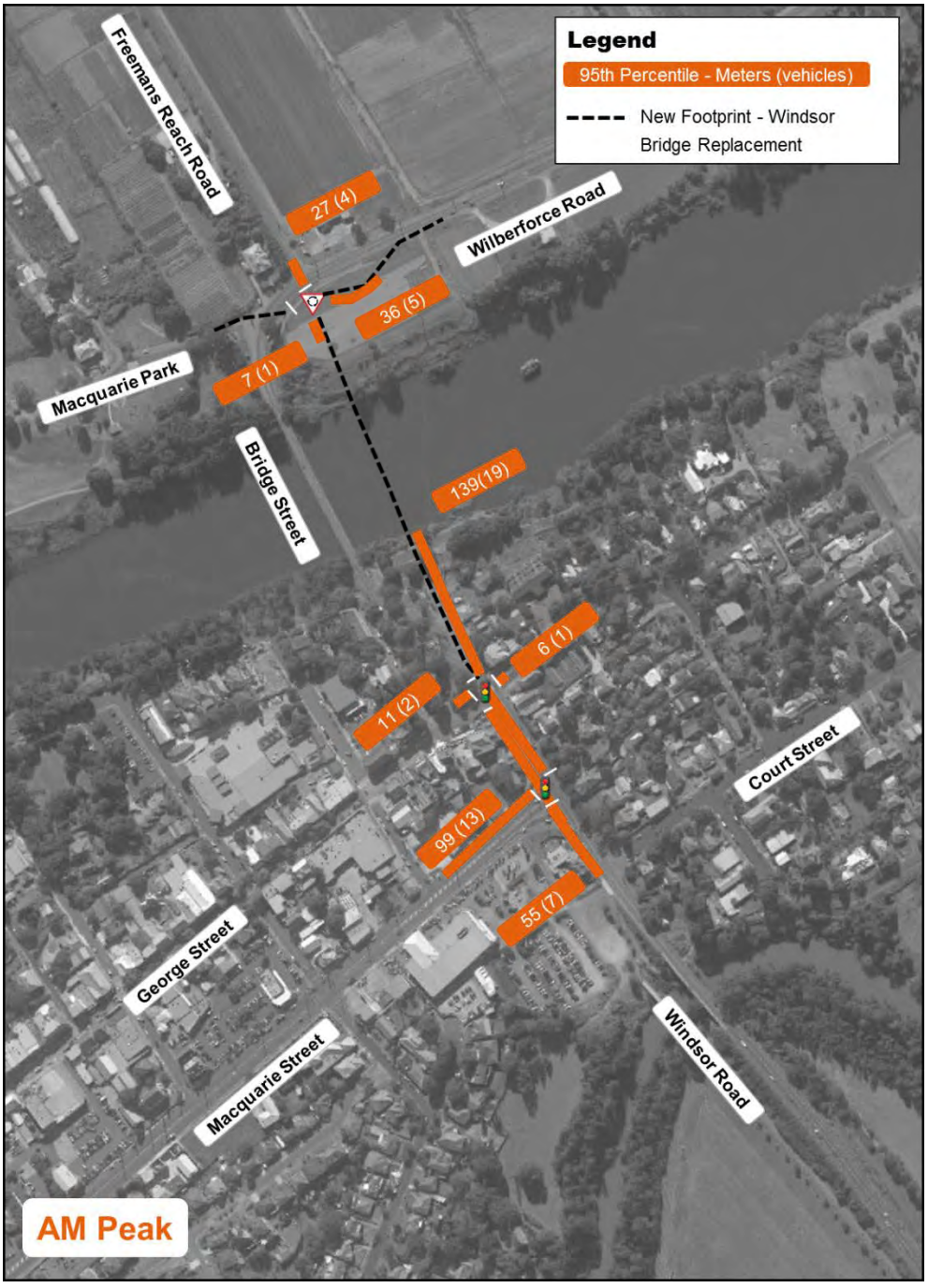


Figure D-1 Predicted 95th Percentile Queue Lengths in 2026 AM Peak with Modified Concept Design

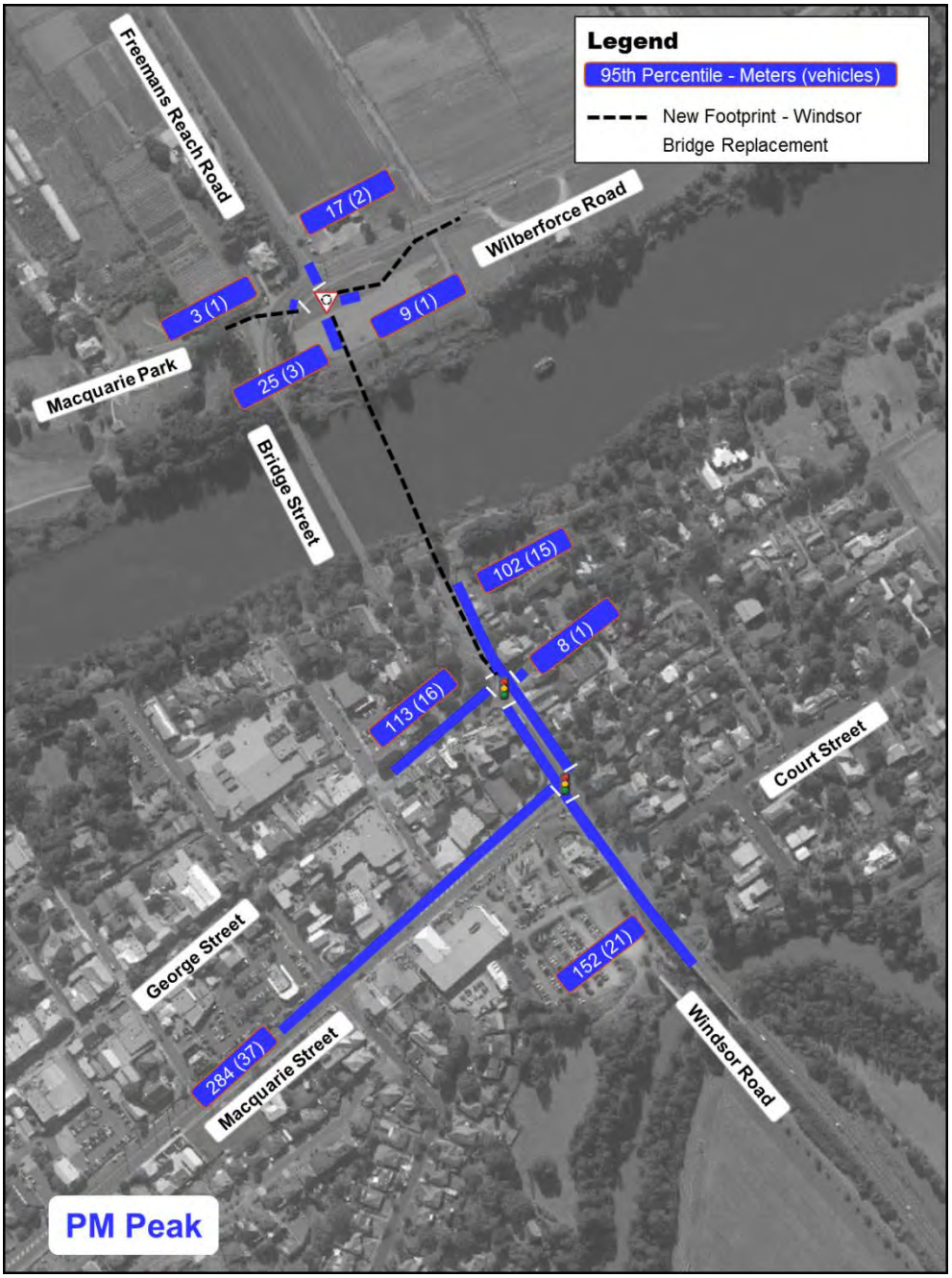


Figure D-2 Predicted 95th Percentile Queue Lengths in 2026 PM Peak with Modified Concept Design

Figure D-3 to Figure D-4 show predicted queue lengths (95th percentile) at Wilberforce Road / Freemans Reach Road, Bridge Street / George Street and Bridge Street / Macquarie Street for 2036 AM and PM with Modified Concept Design.

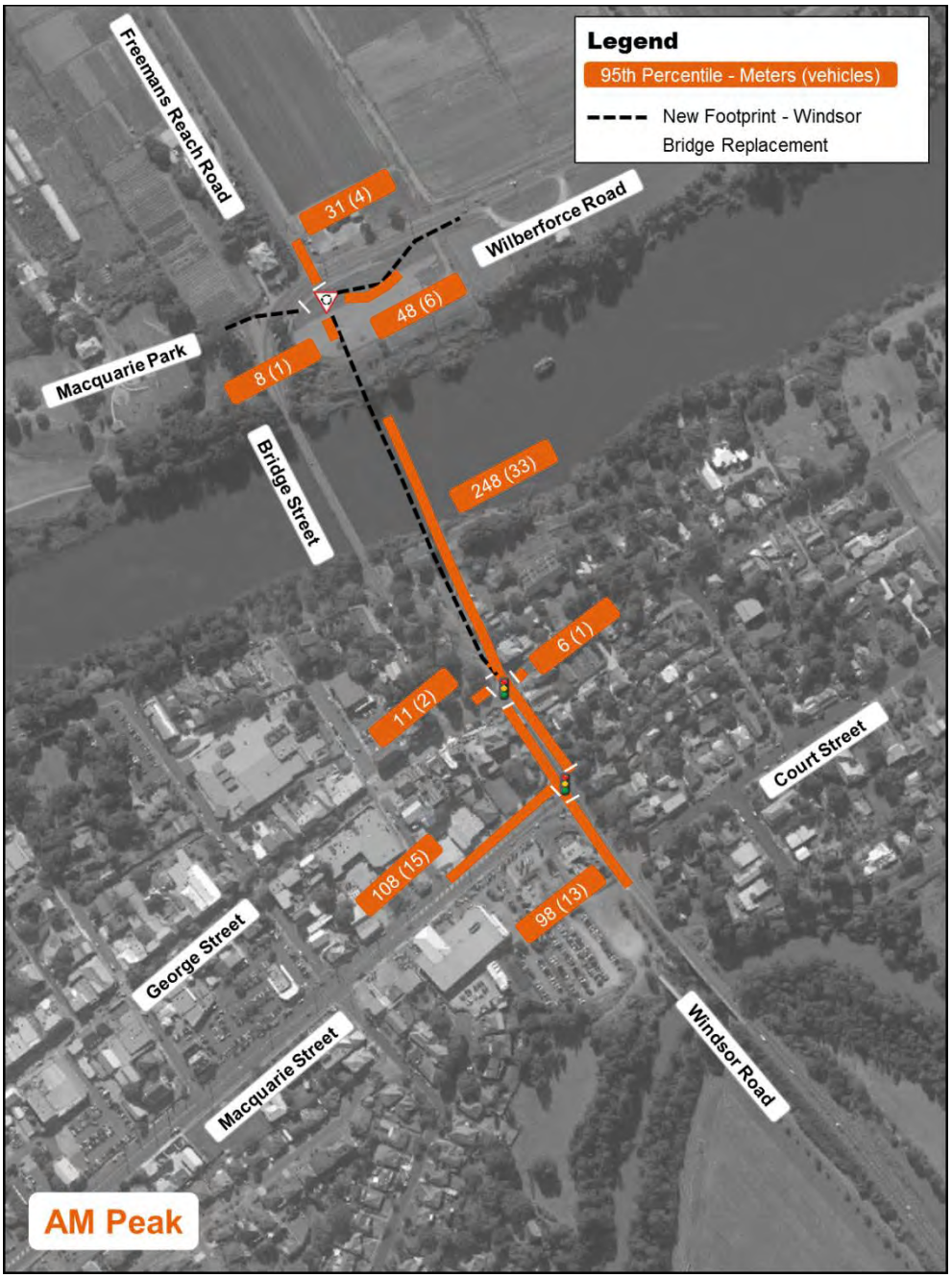


Figure D-3 Predicted 95th Percentile Queue Lengths in 2036 AM Peak with Modified Concept Design

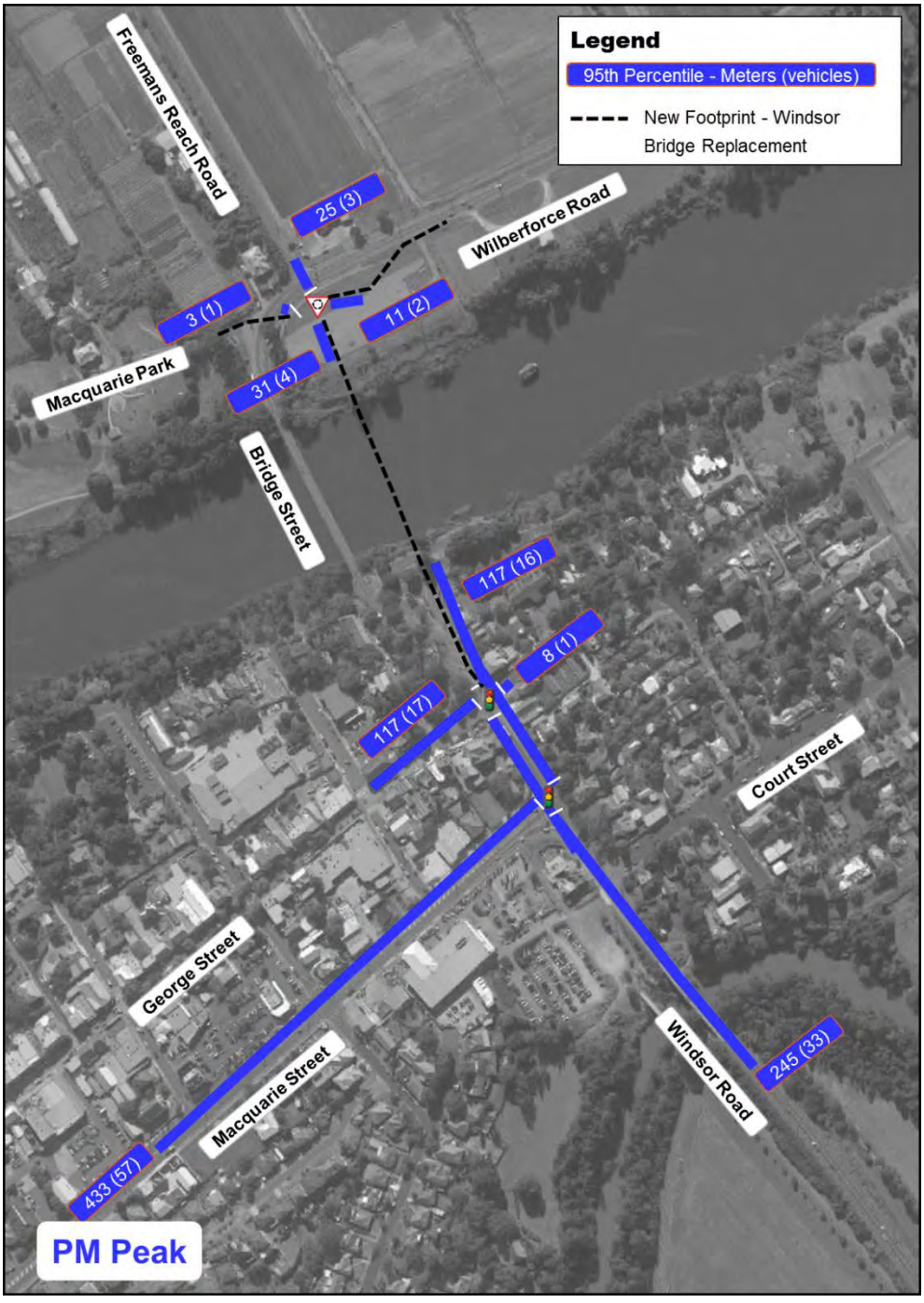


Figure D-4 Predicted 95th Percentile Queue Lengths in 2036 PM Peak with Modified Concept Design

D.2 Level of Service Results (SIDRA) – 2026 with Modified Concept Design

Wilberforce Road / Freemans Reach Road (new roundabout) - 2026 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Freemans Reach Road	11	A	27
East: Wilberforce Road	15	B	36
South: Bridge Street	10	A	7
West: Macquarie Park	11	A	0
Overall (1)	**15**	**B**	

Wilberforce Road / Freemans Reach Road (new roundabout) - 2026 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Freemans Reach Road	16	B	17
East: Wilberforce Road	11	A	9
South: Bridge Street	9	A	25
West: Macquarie Park	17	B	3
Overall (1)	**17**	**B**	

Bridge Street / George Street (new traffic signals) - 2026 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	11	A	139
East: George Street	49	D	6
South: Bridge Street	26	B	122
West: George Street	27	B	11
Overall (2)	**16**	**B**	

Bridge Street / George Street (new traffic signals) - 2026 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	9	A	102
East: George Street	74	F	8
South: Bridge Street	14	A	122
West: George Street	67	E	113
Overall (2)	**20**	**B**	

Bridge Street / Macquarie Street (traffic signals) - 2026 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	11	A	84
South: Bridge Street	12	A	55
West: Macquarie Street	49	D	99
Overall (2)	**20**	**B**	

Bridge Street / Macquarie Street (traffic signals) - 2026 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	31	C	122
South: Bridge Street	35	C	152
West: Macquarie Street	67	E	284
Overall (2)	**48**	**D**	

Note:
(1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay.
(2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

D.3 Level of Service Results (SIDRA) – 2036 with Modified Concept Design

Wilberforce Road / Freemans Reach Road (new roundabout) - 2036 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Freemans Reach Road	11	A	31
East: Wilberforce Road	17	B	48
South: Bridge Street	10	A	8
West: Macquarie Park	11	A	0
Overall (1)	**17**	**B**	

Wilberforce Road / Freemans Reach Road (new roundabout) - 2036 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Freemans Reach Road	19	B	25
East: Wilberforce Road	11	A	11
South: Bridge Street	9	A	31
West: Macquarie Park	19	B	3
Overall (1)	**19**	**B**	

Bridge Street / George Street (new traffic signals) - 2036 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	17	B	248
East: George Street	46	D	6
South: Bridge Street	40	C	122
West: George Street	27	B	11
Overall (2)	**24**	**B**	

Bridge Street / George Street (new traffic signals) - 2036 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	12	A	117
East: George Street	73	F	8
South: Bridge Street	30	C	122
West: George Street	67	E	117
Overall (2)	**30**	**C**	

Bridge Street / Macquarie Street (traffic signals) - 2036 AM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	13	A	116
South: Bridge Street	19	B	98
West: Macquarie Street	47	D	108
Overall (2)	**23**	**B**	

Bridge Street / Macquarie Street (traffic signals) - 2036 PM

Approach / Road	Average Delay (sec)	LoS	95th Percentile Queue (metres)
North: Bridge Street	38	C	122
South: Bridge Street	70	E	245
West: Macquarie Street	117	F	433
Overall (2)	**83**	**F**	

Note:
(1) Priority intersections such as a roundabout and sign controlled intersections, the Level of Service (LoS) value is determined by the critical movement with the highest delay.
(2) Signalised intersection, LoS criteria are related to the average intersection delay measured in seconds per vehicle.

Appendix C – Heritage Assessment

AAJV
2/729 Elizabeth Street
Waterloo NSW 2017
Ph: 02 9555 4000
ABN 39 785 858 339

10 September 2019

Mr Graham Standen
Transport for New South Wales
25-27 Argyle Street
Parramatta NSW 2124

AAJV Ref: SYD16081

Dear Graham,

RE: Windsor Bridge Replacement Project – Review of Heritage Impacts for Northbound Merge Concept Options

Further to your email of 23 July 2019 and the concept design provided for the Northbound Merge Lane (NML) prepared by Jacobs in 2017 (Figure 1), we understand that Roads and Maritime Services (RMS) is proposing two minor design amendments to improve northbound traffic flow. These are (see Figure 1 below):

Amendment 1. Two through lanes at the northbound approach of the Bridge and George street intersection:

- left lane: shared left turn and through lane
- right lane: dedicated through lane.

This would improve traffic flow and reduce travel times by allowing two lanes of northbound traffic to move through the intersection, rather than one.

Amendment 2. A new merge lane exiting the Bridge and George street intersection:

- 100 metres long (including a 30 metre parallel lane and 70 metre 'zip' merge lane)
- the lane merges into one northbound lane on the new bridge

The proposed 'zip' merge lane would improve traffic flow by allowing two lanes to merge onto the bridge.

We have reviewed the heritage and archaeological impacts of this proposed design change and provide the following advice.

Existing Environment

A description of the existing environment and conditions of the areas to be impacted is outlined below.

Amendment 1. Two through lanes at the northbound approach of the Bridge and George street intersection.

The area in the immediate vicinity of the proposed works is currently brick paved and comprises part of the footpath with sandstone kerbing (see Figure 1). Line marking is the only physical work associated with this amendment and, as such, there are no anticipated impacts in relation to heritage.

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Amendment 2. A new merge lane exiting the Bridge and George street intersection.

Amendment 2 includes a new merge lane exiting the Bridge Street and George Street intersection for traffic travelling north toward the new bridge. The new merge lane would require a narrow and tapering strip of land in the south-east corner of Thompson Square. This strip of land will measure between zero and 3 metres in width over a length of 100 metres.

At the upper and southern end of the proposed merge lane, the widening comprises an existing area of grass and bare earth on the road verge. At the lower and northern end of the merge lane the area will be comprised of fill placed above the surface of the existing Bridge Street.

Proposed Impact

As described above, the lane design will encroach on the sandstone kerbing of the south-east corner of Thompson Square. The additional area will form a tapered band along the western edge of the bridge approach, up to 3 metres in width for a distance of approximately 100 metres. The entirety of this area is within the 4 metre impact buffer previously allowed for in the development of the archaeological management recommendations set out in the Detailed Salvage Strategy.

Aboriginal Archaeological Impacts

Impact Assessment

The proposed NML in this area will draw the construction works closer to the area of highly significant Aboriginal archaeological sensitivity in terms of the preserved Pleistocene sand body within Thompson Square (Figures 2 and 3). The main area of sensitivity is in the vicinity of test pit SA11, which will remain outside of the area of direct impact from the proposed NML. While not directly impacted, test pits SA12 and SA13, containing a low to moderately significant 'ridgeline archaeological landscape' deposit, would now fall within the revised buffer zone for the impact corridor. It should be noted however that applying a further 4 metre buffer zone beyond the NML would result in works coming extremely close to SA11 and its surrounding deposits (i.e. within 3 metres).

Management Measures

It is therefore recommended that any buffer zone (marked in orange on Figure 3) is reduced as much as possible (if not completely removed) along its entire length and turned into a solid boundary through the use of temporary fencing to enforce a hard barrier which may not be crossed under any circumstances, in order to increase this distance from construction areas of Aboriginal sensitivity, and that no direct impact (i.e. excavation) is permitted within the buffer zone. Indirect impacts must also be managed (e.g. surface protection for heavy vehicles, etc).

If this approach is adopted, we do not foresee additional Aboriginal archaeological impacts, and no changes to the recommendations of the Detailed Salvage Strategy would be required. If unfeasible, additional recommendations to the management of Aboriginal heritage would be required in the form of further on-site works and recovery of cultural materials.

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Historical Archaeological Impacts

Impact Assessment

The proposed location of the NML is within an area suspected to contain historical archaeological deposits and relics, based on the 2016 archaeological testing works. Historical research has indicated historical usage in this part of Thompson Square was ephemeral in nature and archaeological testing revealed a very shallow depth of deposit in this general area, which may be disturbed by the construction of the NML. This additional area is partially within the area already identified for historical archaeological salvage (referred to as Area 1 in the Detailed Salvage Strategy) or is within the nominated area for historical archaeological monitoring. See Figures 4 to 7 below for an illustration of impacts on areas of historical archaeological sensitivity and associated management recommendations. The area of the NML should be managed in accordance with these recommendations.

Management Measures

The proposed lane design does not change our recommendations for historical archaeological salvage in terms of the Detailed Salvage Strategy.

The area of the NML should be managed in accordance with these recommendations as illustrated in Figure 7.

Landscape and Boundary Heritage Impacts

Impact Assessment

The proposed NML will have an additional negative impact on the configuration of Thompson Square by encroaching on an additional ~160 metres^2 of the eastern side of Thompson Square. This will have no direct impact on above-ground historic features or landscape elements, however it will represent a further reduction in the size of Thompson Square. This section of Thompson Square has been the subject of previous impacts and size reductions due to past road works. The cumulative impact of this design change is minor within the context of the project, while further reductions in the size of Thompson Square are not desirable, the design modification is acceptable from a heritage standpoint in the event that the following management measures are implemented.

Management Measures

The proposed NML design requires some modifications to the Urban Design and landscaping. These modifications are detailed in the "Windsor Bridge Replacement Project - Bridge Street Merge Modification Urban Design and Landscape Memo"f, by Spackman Mossop Michaels

The proposed NML design does not change our recommendations in terms of the Strategic Conservation Management Plan or Interpretation Plan.

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Should you have any questions, please contact me on 0417 084 396

Yours sincerely,

David Marcus

Heritage Manager / Director (Austral Archaeology)

On behalf of the AAJV

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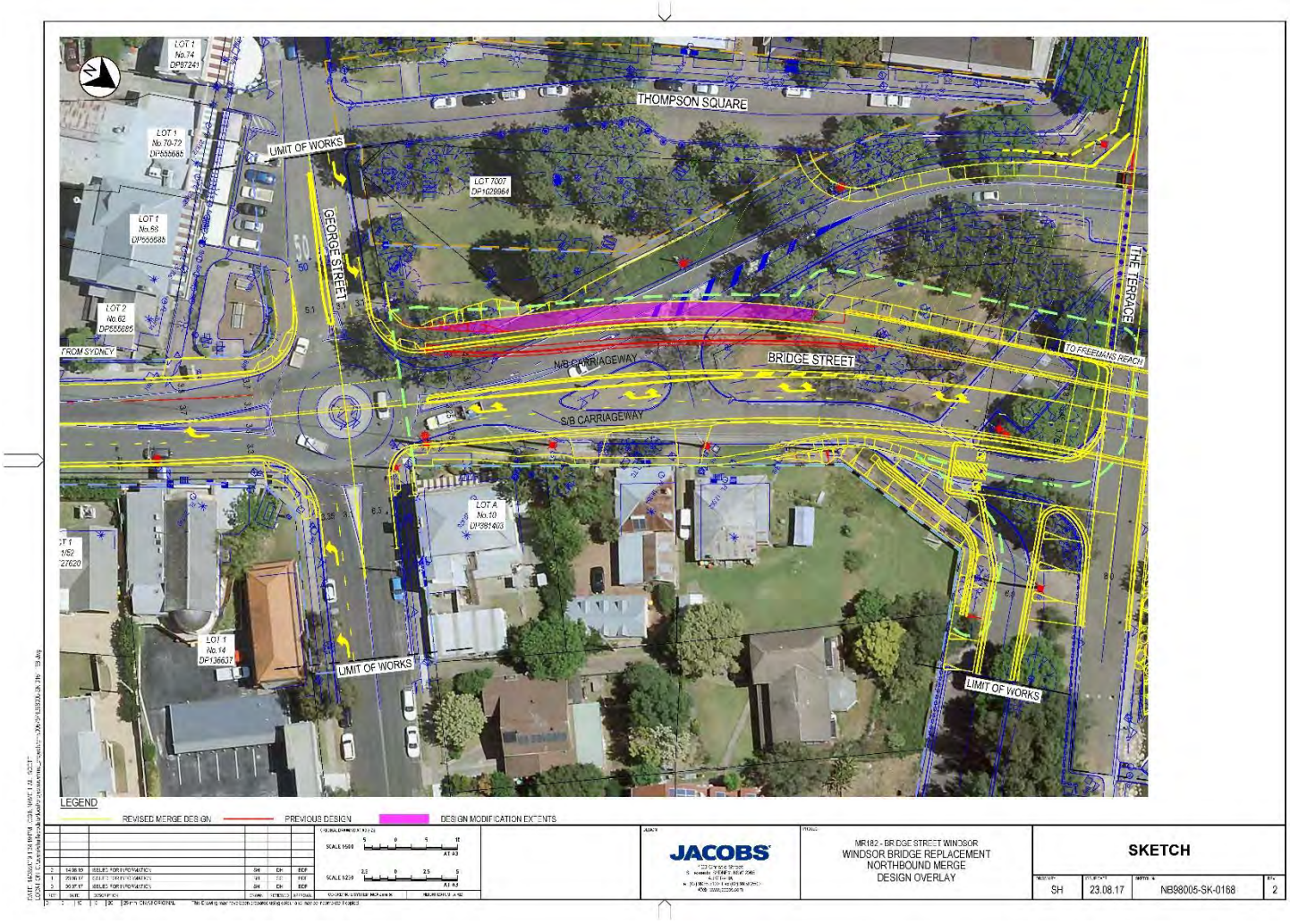

Figure 1 – Concept Design for Northbound Merge Lane

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Photo 1 – View to north-west of area for proposed changes as described in Amendment 2. Bridge Street at right and George Street at left.

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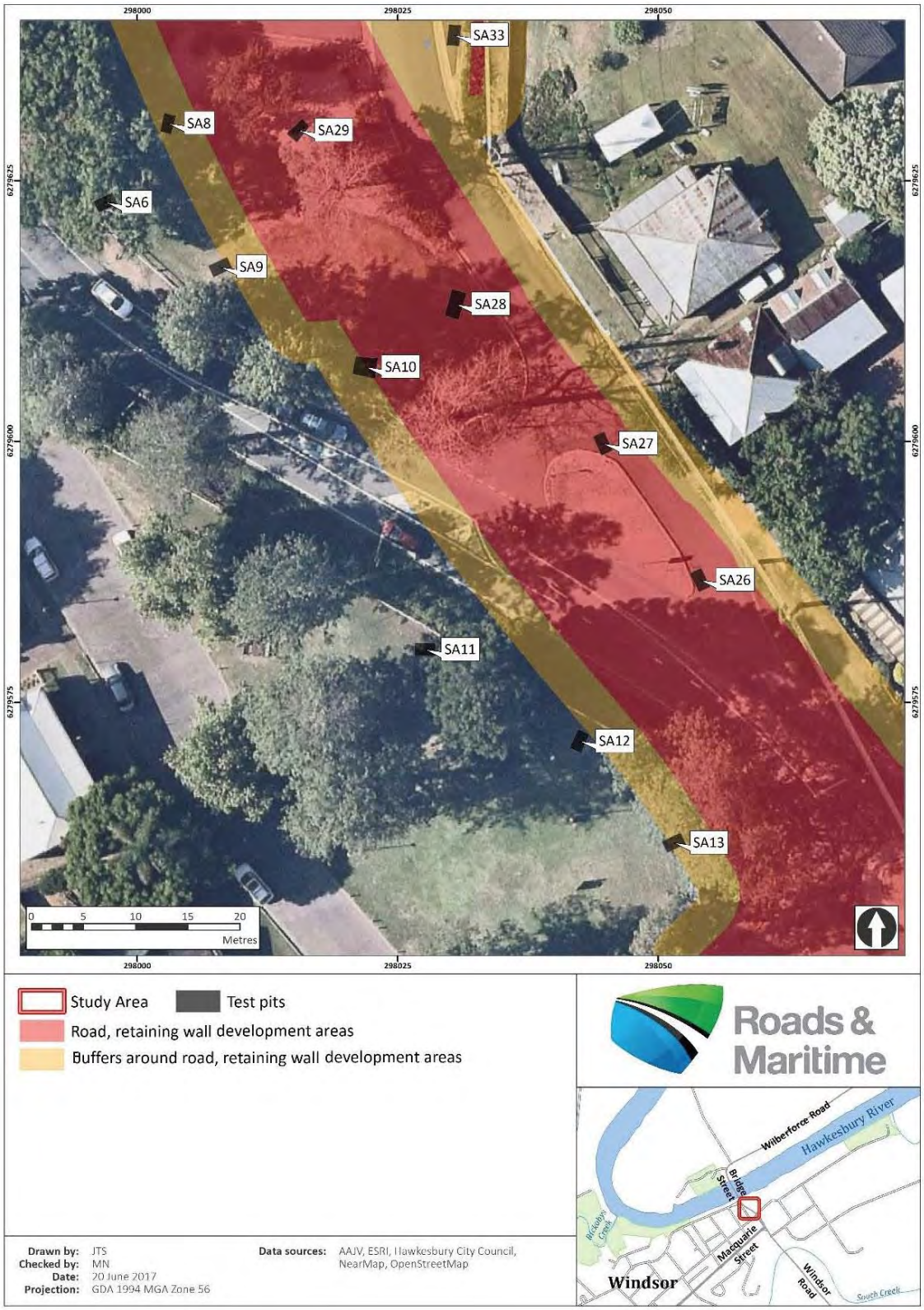

Figure 2 – Approved design relative to Aboriginal test pits.

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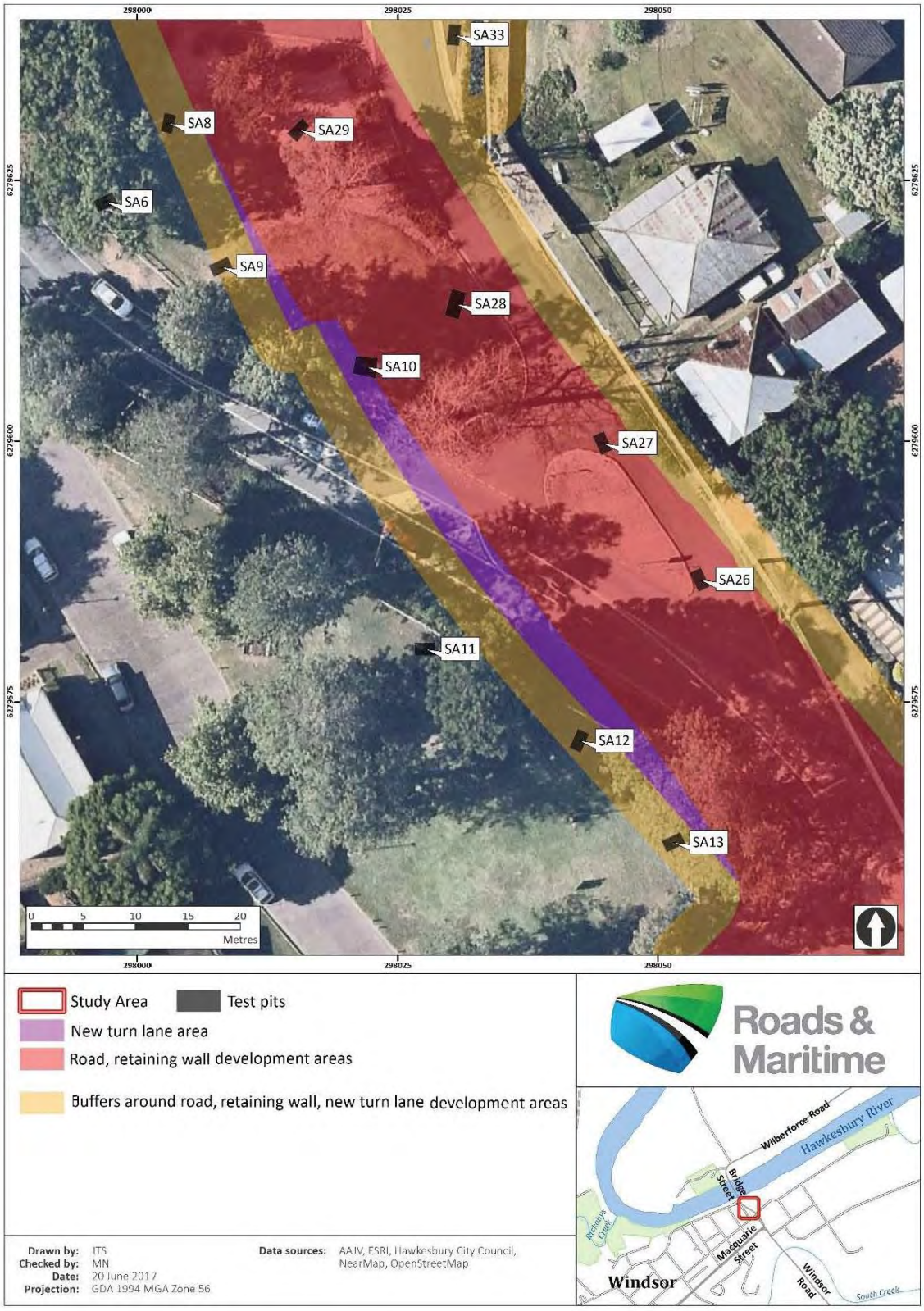

Figure 3 – Additional impact zone for northbound land relative to Aboriginal test pits. The vicinity of SA11 and surrounds is the most archaeologically sensitive area.

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Figure 4 – Approved design in relationship to historic test trenches.

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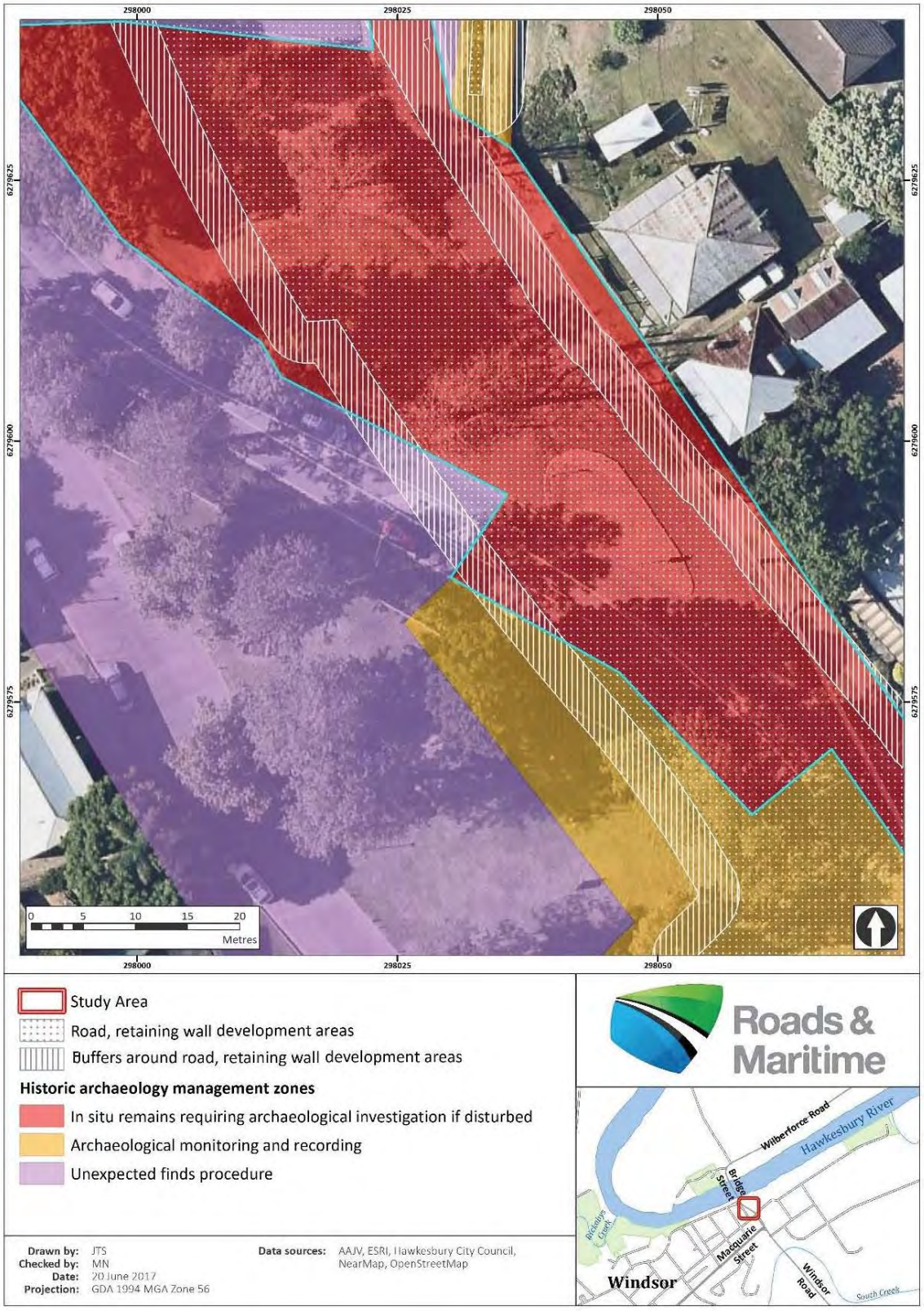

Figure 5 – Approved design and relationship to historical archaeological management recommendations.

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Figure 6 – Additional impact zone for northbound lane in relation to historical archaeological test trenches.

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ABN 39 785 858 339

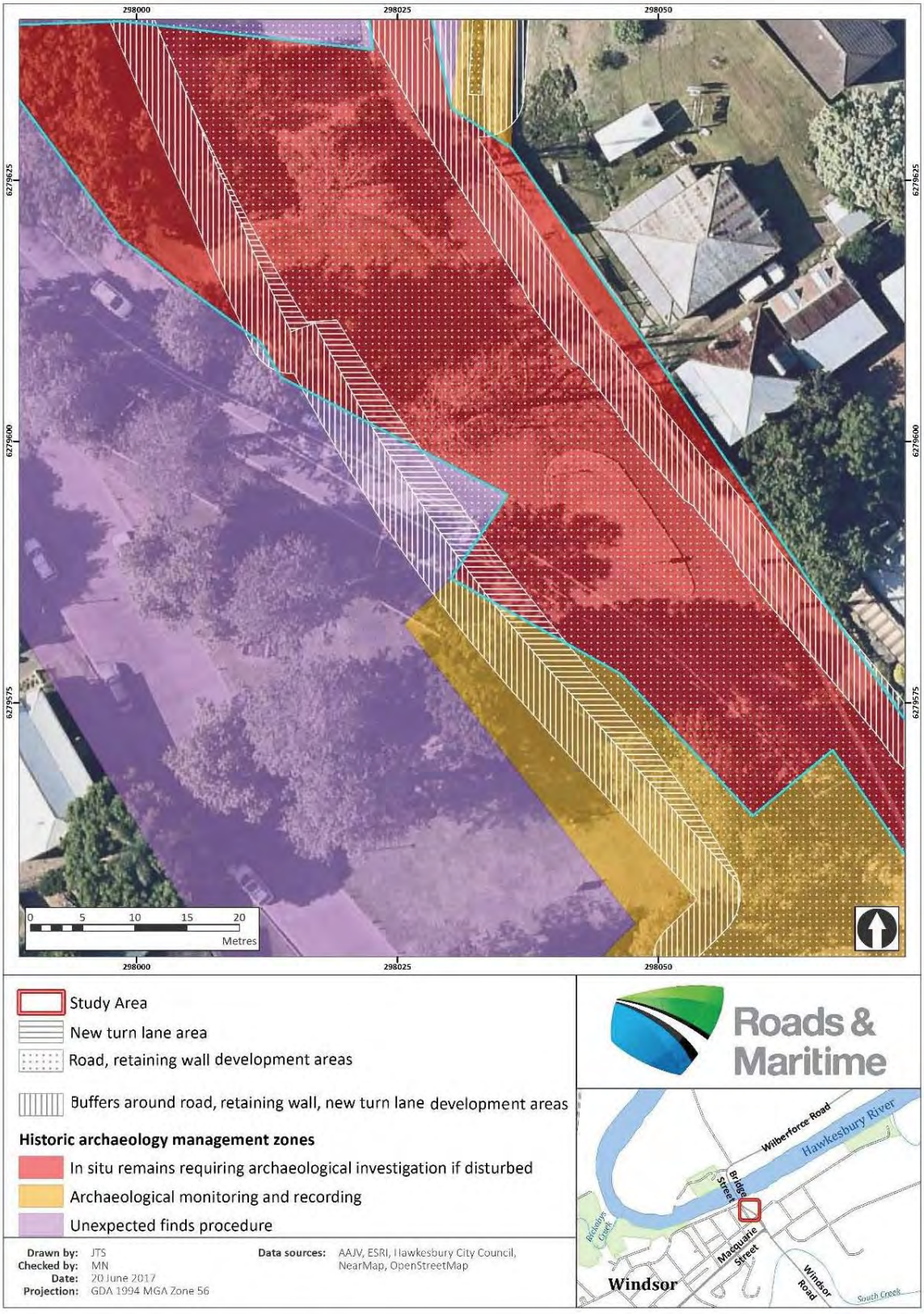

Figure 7 – Additional impact zone for northbound lane and relationship to historical archaeological management recommendations.

Appendix D – Arboricultural Impact Assessment

ARBORICULTURAL IMPACT ASSESSMENT

Windsor Bridge Replacement Project

Version 1

Prepared for:
Cardno

TREE SURVEY
ARBORICULTURAL CONSULTANTS

06 July 2019

Introduction

Tree Survey was commissioned by Cardno on behalf of Roads and Maritime Services to prepare an Arboricultural Impact Assessment (AIA) for a single tree (***Araucaria cunninghamii***) located within Thompson Square, Windsor. This AIA has been prepared in response to the proposed realignment of Bridge Street for the Windsor Bridge Replacement Project.

The purpose of the AIA is to:

- Assess the current health and condition of the subject tree.
- Evaluate the significance of the subject tree and its suitability for retention.
- Provide recommendations for site-specific tree-sensitive excavation/construction methods, and other measures which may mitigate the likely impacts of the works.

It is noted that the species of this tree was incorrectly identified as an ***Araucaria bidwillii*** (Bunya Pine) in the Windsor Bridge EIS - Urban Design Working Paper. The species of the tree has been confirmed as ***Araucaria cunninghamii*** (Hoop Pine).

Method

The site inspection was carried out on the 5 July 2019. The subject tree was assessed in accordance with a stage one visual tree assessment (VTA) as formulated by Mattheck & Breloer (1994) [1], and practices consistent with modern arboriculture. The conclusions and recommendations of this report are based on the findings from the site inspections, discussions with the project team and analysis of the following documents:

- *Australian Standard, AS 4970-2009, Protection of Trees on Development Sites.*
- *Northbound Merge Design Overlay (Drawing) prepared by Jacobs dated 23/08/17.*

[1] VTA is an internationally recognised practice in the visual assessment of trees as formulated by Mattheck & Breloer (1994). Principle explanations and illustrations are contained within the publication, Field Guide for Visual Tree Assessment by Mattheck, C., and Breloer, H. Arboricultural Journa1, Vol 18 pp 1-23 (1994).

Observations

The subject tree (***Araucaria cunninghamii***) is approximately **28m** in height, with a canopy spread of **14m** and a trunk diameter at breast height (DBH) of **1300mm**. The following observations were made during the site inspection:

- The tree is located towards the north-eastern boundary of Thompson Square adjacent to Bridge St.
- This tree has been assessed as a high priority for retention due to its size and heritage significance.
- The overall health and condition of the tree are good. The canopy is thick and shows little signs of discolouration and dieback.
- The tree protection zone (TPZ) for this tree has been calculated at **15.0m** radius from the centre of the trunk.
- The structural root zone (SRZ) has been calculated at **3.7m** radius from the centre of the trunk (or **3.0m** from the edge of the trunk).
- The existing road and batter currently fall within the TPZ.
- The edge of the proposed road alignment is located between **6.0m-9.0m** from the centre of the trunk.
- A batter and/or retaining wall(s) will be required between the edge of the proposed road alignment and the subject tree. These proposed works are also located within the TPZ.

Discussion

The TPZ is the optimal combination of crown and root area that requires protection during the construction process so that the tree can remain viable. The TPZ is an area that is isolated from the work zone to ensure no disturbance or encroachment occurs into this zone. The TPZ (as defined by *AS 4970-2009*) is calculated by measuring the DBH and multiplying it by twelve (12). The resulting value is applied as a radial measurement from the centre of the trunk to delineate the TPZ.

Encroachment within the TPZ is acceptable providing that the arborist can demonstrate that the tree will remain viable. In general, up to 25% encroachment is usually considered acceptable providing that the tree is healthy, and a number of mitigation measures are applied. Encroachment of greater than 25% (of the total TPZ area) can begin to impact upon the SRZ and is generally more difficult to mitigate. Impacts within the SRZ are not recommended as it may lead to the destabilisation and/or decline of the tree.

The current proposed road alignment is located far enough away from the tree that it will not cause any significant impacts. However, the proposed batter and/or retaining walls located between the edge of the proposed road alignment and the tree may have potential to cause impacts if a tree sensitive design is not utilised.

The top of the existing batter is located **3.0m** from the trunk of the tree and provides an excellent delineation for the SRZ and the minimum distance between any proposed works and the subject tree. The closest point of any excavation should be located at least **3.0m** from the subject tree (measured from the edge of the trunk). Excavations that fall beyond the **3.0m** delineation would require further investigation through the use of non-destructive excavation under supervision of the project arborist.

Recommendations

Two (2) tree-sensitive options have been provided to assist the design and construction of the retaining walls and/or batter located between the proposed road alignment and the subject tree:

- **Option 1:** All proposed work is located at least **3.0m** from the subject tree (measured from the edge of the trunk). This option would not require further root investigation or assessment by the project arborist.
- **Option 2:** The proposed work falls within **3.0m** of the subject tree (measured from the edge of the trunk). This option would require further root investigation (by non-destructive methods) under the supervision of the project arborist. Any proposed excavations that fall within **2.5m** of the tree are not recommended and are likely to cause impacts that cannot be mitigated through the use of tree protection measures and/or tree sensitive construction techniques.

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Appendix I - Tree images

Figure 1: The subject tree

Figure 2: Example of the 3.0m delineation on site

Appendix E – Landscape Character and Visual Amenity

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NSW GOVERNMENT | Transport Roads & Maritime Services

Windsor Bridge Replacement Project Bridge Street Merge Modification

Landscape Character and
Visual Impact Assessment Memo

Revision 08
19 September 2019

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01	01.08.2017	Preliminary Draft LCVIA Memo	MW/EH	MW
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06	17.09.2019	Final	MW/EH	MW
07	18.09.2019	Final	MW/EH	MW
08	19.09.2019	Final	MW/EH	MW

Contents

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Introduction

Section 01

01 Introduction

1.1 Purpose of this Memo

Roads and Maritime Services (Roads and Maritime) are constructing a new bridge across the Hawkesbury River at Windsor to replace the existing bridge that has reached the end of its economic life (the original Project). Infrastructure approval for the original Project was granted on 20 December 2013 based on the Windsor Bridge Replacement Project Environmental Impact Statement Volumes 1, 2, 3 and 4 (November, 2012) (original Project EIS) prepared by Sinclair Knight Merz (SKM) and the subsequent Windsor Bridge Replacement Project Submissions Report incorporating Preferred Infrastructure Report (April, 2013) (Submissions Report) prepared by SKM.

The original Project EIS was supported by an Urban Design and Landscape Concept Report (including Landscape Character and Visual Impact Assessment) (October 2012) (original UD&L report) prepared by Spackman Mossop Michaels and Hill Thalis (SMM and HT), that provided an assessment of impact of the original Project. The assessment included Identifying urban design and landscape strategies in order to mitigate adverse impacts.

Following the determination to proceed with the original Project, Jacobs (previously SKM) have carried out detailed design. The detailed design process has identified a number of design amendments including the widening of Bridge Street and proposed merge lane (the Proposal).

This memo has been prepared to assess and document the potential landscape character and visual impacts of the Bridge Street merge modification. This memo includes a recommendation for feasible and reasonable mitigation measures to be implemented for the Proposal.

1.2 Description of Proposal

Roads and Maritime is proposing two relatively minor design amendments (refer to Figure 1) to improve northbound traffic flow as follows:

- Amendment 1: Two through lanes at the northbound approach of the Bridge and George Street intersection:
  - left lane: shared left turn and through lane
  - right lane: dedicated through lane.

This would improve traffic flow and reduce travel times by allowing two lanes of northbound traffic to move through the intersection, rather than one. There will be no changes required to the Bridge Street (south) alignment or kerbs on the southern approaches to the intersection.

- Amendment 2: A new merge lane exiting the Bridge and George Streets intersection:
  - 100 metres long (including a 30 metre parallel lane and 70 metre 'zip' merge lane)
  - the lane merges into one northbound lane on the new bridge.

This reduces congestion by allowing motorists to stay in their lanes right up until the merge point. This proposal will require the widening of Bridge Street (north) moving the kerb into the parkland of Thompson Square by up to 3m over approximately 70m of the parkland frontage. The balance of the merge lane widening is to occur on the bridge abutment.

1.3 Assessment Methodology

The method used to undertake this assessment of the proposed merge lane (the 'Proposal') follows the 'Guideline for Landscape Character and Visual Impact Assessment' (Roads and Maritime Services, 2018). This is the same guide used for the EIS however it has been subsequentially updated since that time.

A desktop review was carried out to identify the potential impacts of the proposed merge lane on landscape character and visual amenity. The Proposal would affect one landscape character zone (LCZ) and six of the 18 viewpoints assessed in Section 7.4 of the EIS and the Urban Design and Landscape Concept Report (including Landscape Character and Visual Impact Assessment) working paper (SMM and HT, 2012) (Volume 3 of the EIS). The implications of the Proposal are discussed below.

01

Figure 1. Proposed merge lane modification

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Landscape Character Assessment

Section 02

02 Landscape Character Impact

2.1 Landscape Character Overview

Three landscape character zones (LCZ) were identified in the EIS. The desktop assessment found that the Proposal would impact on one LCZ. This is discussed below.

LCZ 1: Thompson Square

Existing Landscape Character

The parkland of Thompson Square dominates the landscape character of LCZ 1. This landscape is characterised by large mature ornamental trees which contrast markedly with the urban surroundings of Windsor. The parkland is generally defined by surrounding buildings on three sides and roadways on all four sides. The parkland is also diagonally dissected from east to west by Bridge Street, providing vehicular access to the existing bridge, and its deep cutting, physically and visually separating the space into two distinct open space areas.

The buildings surrounding Thompson Square comprise of one and two storey colonial buildings and are set around three sides of the park. The recently restored buildings provide a strong physical edge and sense of containment to the square, as well as a unified heritage quality, which together form the Thompson Square Conservation Area.

The upper area of Thompson Square offers the best amenity with easy access to the adjoining retail outlets on George Street. The upper area consists of a generally level open grassed area with a number of mature trees planted informally around the space, providing an attractive, enclosed parkland setting. Park furniture is scattered around this area providing picnic facilities for casual use. The Memorial and white rail on edge fencing add a civic quality to the area. The cutting provides a degree of visual separation from Bridge Street and its constant traffic.

The lower area is of low landscape amenity with poor pedestrian access due to the steeper grades and road infrastructure, including a small carpark. The topography has been artificially mounded, forming a small promontory that offers views out towards the river and opposing riverbank and provides the only usable green space.

The approved Windsor Bridge Replacement Project which is currently under construction, will reunite the upper and lower sections of the parkland in Thompson Square with the removal of the current Bridge Street alignment connecting to the existing bridge.

The first span of the current bridge will be retained as a viewing platform and The Terrace which runs parallel to the river, will be converted to a slow speed Shared Zone with a speed limit of 10kph and raised brick road surface to match the paths around the Square. This will have the effect of extending the Thompson Square parkland into a corridor of continuous open space between George Street and the Hawkesbury River.

As a result of these changes, the expanded parkland will increase the extent of usable recreation space with higher levels of amenity than the existing situation. The parkland will not only have better visual connections to the river but also have better physical connections between George Street and the river. This will have the effect of expanding the areas of high amenity parkland within Thompson Square.

Landscape Character Assessment

The EIS identified the landscape character sensitivity of LCZ 1 to be High and the magnitude of the impacts from the upgrade to be High to Moderate, giving an overall landscape character impact of High. The high sensitivity rating is based on the cultural heritage values of the built form surrounding the Thompson Square and the intervening open space which includes the parkland with mature trees which creates high value recreational amenity. Refer to Figure 2.

The Proposal would increase the width of Bridge Street by up to 3 metres compared to the original Project. This would have a minimal impact on the magnitude rating, which would remain High to Moderate. Therefore, the landscape character impact rating would remain High.

Discussion

While the Landscape Character Impact Assessment rates the overall impact as high, it is however important to recognise that the high value of the parkland in Thompson Square means that even relatively small incursions into the parkland will be perceived as potentially having a higher impact than in other areas of open space in the local area.

The area of parkland that would be directly affected is located adjacent to the road (Bridge Street) and as the plan and cross sections in Figures 3 and 4 illustrate, the highest value parkland from an amenity and usage perspective is in the central area of the parkland which offers not only some increased separation from the road but also an elevated setting providing views over the parkland and road to the river and floodplain beyond.

02

The plan and cross sections also indicate the edges of the parkland that are likely to be affected by their proximity to Bridge Street and the road on the western edge of Thompson Square, from an amenity and usage perspective. Along both of these parkland edges are landscape areas which separate the higher value amenity parkland areas from the adjacent roads. The Bridge Street frontage has a wider area as it is adjacent to a main road whereas the road in Thompson Square is a slow speed one way road with brick pavement. The retained trees and the proposed new tree planting along the Bridge Street frontage will assist in maintaining the high amenity values in both the central area of the parkland and the areas adjacent to Bridge Street.

In this proposal, the additional merge lane would reduce the area of parkland by up to 3m in width over approximately 70m of parkland frontage, and this would potentially have some effect on higher amenity central areas as the edge of Bridge Street moves into the southern section of the parkland.

However as the plan and sections on the following page illustrate, the majority of the area of parkland is retained and the physical access and view corridor through to the river is also unaffected.

All of the trees, existing and proposed, identified to be retained and planted in the current approved project would be retained in the proposal for the merge lane. A number of additional trees could be planted along the frontage of Bridge Street if an increased level of separation is required, subject to consultation with Council.

Approximately 160m^2 or approximately 5% of the grassed area in the Thompson Square parkland would be removed and replaced with additional road pavement. As a consequence, the degree of change between the existing and the proposed merge lane would be relatively moderate.

Figure 2. View of the upper section of the parkland in Thompson Square.

02

Figure 3. Plan of Thompson Square illustrating the retained high amenity parkland and the notional landscape buffer

02

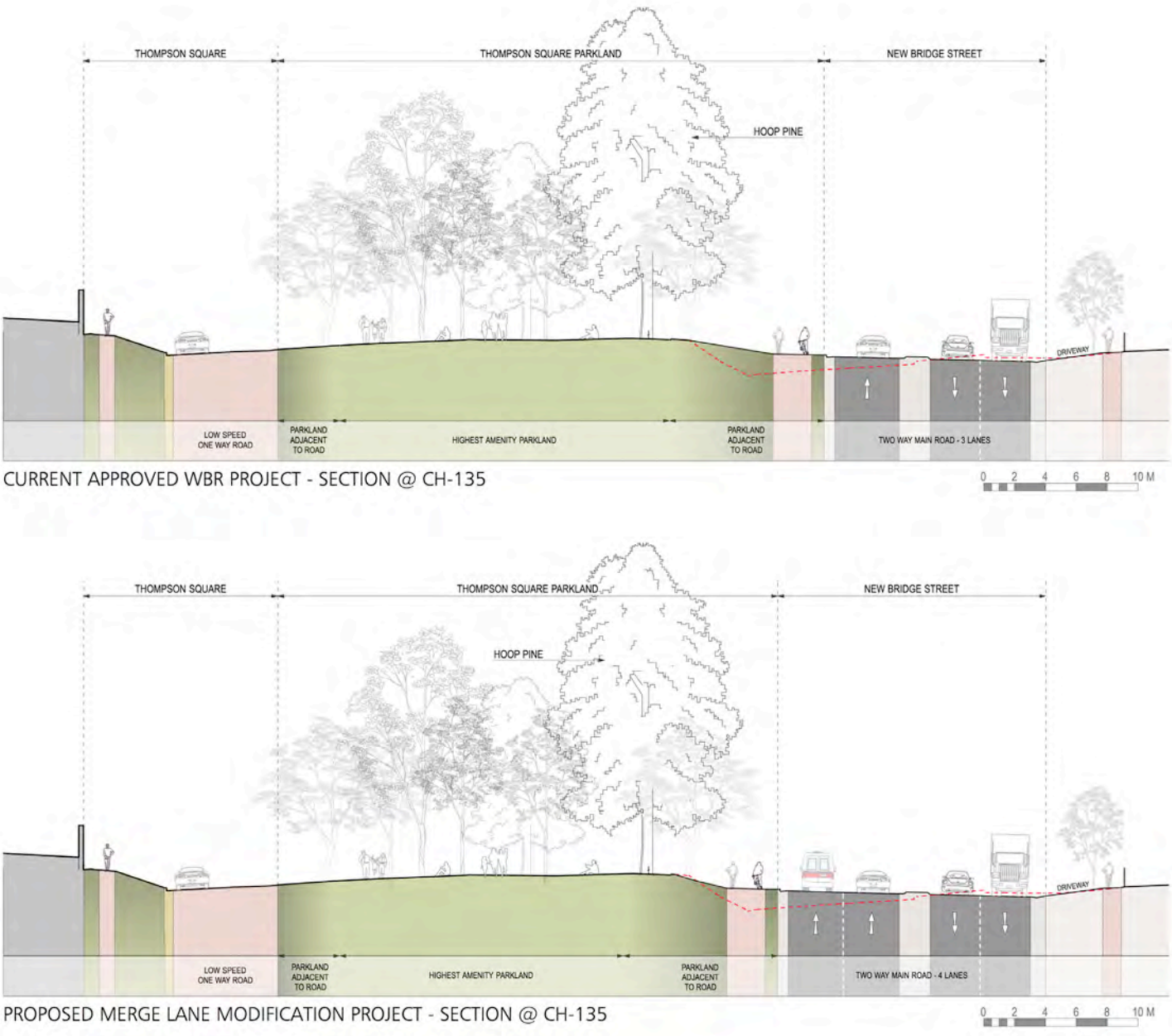

Figure 4. Cross sections illustrating the difference between the current project and the Merge Lane proposal

02

2.2 Photomontages

The following plan and 2 sets of photomontages have been prepared to illustrate the degree of visual contrast between the current approved Windsor Bridge Replacement Project works on Bridge Street and the proposed Merge Lane Modification works from the same viewpoint. These views were chosen to illustrate the areas of greatest visual change along the parkland edge. The plan (Figure 5) illustrates the current road works design and the proposed Merge Lane Modification plus the locations of the 2 viewpoints used in the photomontages. There are 2 photos which show the existing conditions from each viewpoint (Figures 6-7) and these are followed by the 4 photomontages (Figures 8-11).

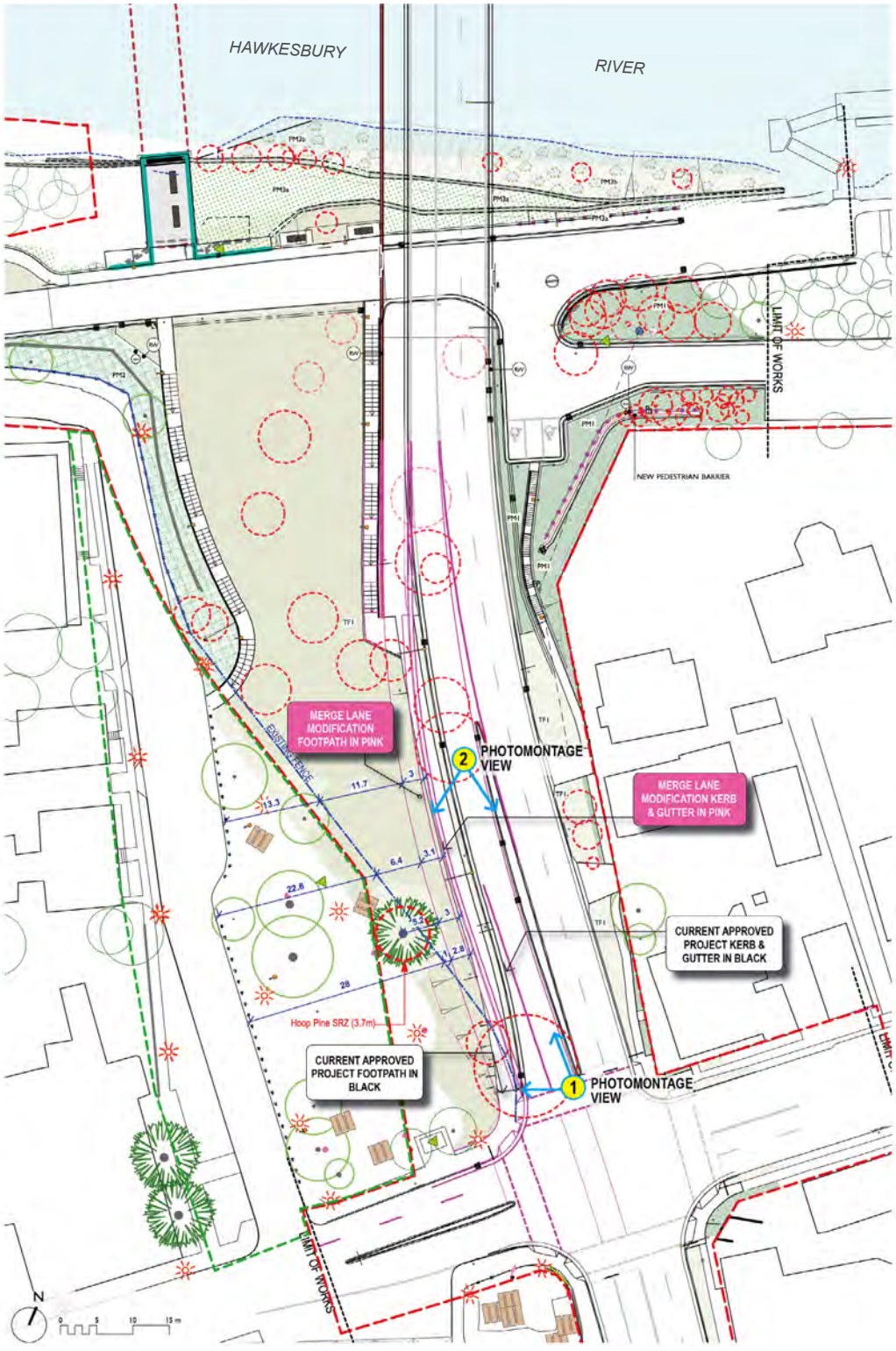

Figure 5. Location of the proposed merge lane option and the location of the 2 viewpoints used in the visualisations

02

Figure 6. View 1 - Existing site photo looking west down Bridge Street towards the old Windsor Bridge

Figure 7. View 2 - Existing site photo looking south up Bridge Street towards the George Street intersection

02

Figure 8. View 1 - Visualisation of the approved lane configuration on Bridge Street north - looking west

Figure 9. View 1 - Visualisation of the proposed merge lane configuration on Bridge Street looking west

02

Figure 10. View 2 - Visualisation of the approved lane configuration on Bridge Street looking south

Figure 11. View 2 - Visualisation of the proposed merge lane configuration on Bridge Street looking south

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Visual Impact Assessment

Section 03

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03 Visual Impact

The desktop assessment found that the Proposal would affect five of the 18 viewpoints for the original Project, namely: viewpoints 3, 4, 5, 6 and 7.

Viewpoint 3

Location

George Street, 100 metres east of Bridge Street, looking south west.

Description

This section of George Street is predominately residential with two motels nearby. There is a slight slope away from the Bridge Street intersection.

Visual impact assessment

The Proposal would not change the sensitivity rating assessed in the EIS, which would remain Low. Due to the distance of the viewer from the Proposal, there would be no change to the magnitude of the visual impact, assessed as Low in the EIS. Therefore, the overall visual impact rating would remain Low.

Viewpoint 4

Location

Seating area on south side of George Street, near Bridge Street intersection, looking north west.

Description

Located at the eastern end of Windsor's retail precinct, with a mix of cafes and restaurants, opposite Thompson Square. There is a small raised seating area, separated from George Street by a low Box hedge. The trees in Thompson Square provide shade to this area in the afternoon and limit views to the north towards the river. The Memorial and white rail on edge fencing add a civic quality to the area.

Visual impact assessment

The Proposal would not change the sensitivity rating assessed in the EIS, which would remain High. The Proposal widens Bridge Street by approximately 3 metres compared to the original Project, however, no additional trees are proposed to be removed. The increased road width would not be apparent from this viewpoint as Bridge Street north slopes away below the ridgeline, maintaining a Moderate magnitude rating. Therefore, the overall visual impact rating would remain High to Moderate.

03

Viewpoint 5

Location

Bridge Street, at the entrance to the former River Music store, looking north west.

Description

Bridge Street begins to descend to the river foreshore and divides into Bridge Street (connecting to Windsor Bridge) and Old Bridge Street at this location. Three buildings front Old Bridge Street, including the historic building that housed the former River Music. A low vegetated embankment, to the edge of Thompson Square, sits opposite.

Visual impact assessment

The Proposal would not change the sensitivity rating assessed in the EIS, which would remain High. The Proposal widens Bridge Street by approximately 3 metres compared to the original Project, however, no additional trees are proposed to be removed. The increased road width would be noticeable from this viewpoint, however, would not be sufficient to increase the existing Moderate magnitude rating. Therefore, the overall visual impact rating would remain High to Moderate.

Viewpoint 6

Location

Thompson Square, at the entrance to Macquarie Arms Hotel, looking north.

Description

The historic Macquarie Arms Hotel is located opposite the Thompson Square road at the corner of George Street. It overlooks the treed parklands and Memorial and the buildings to the north eastern side of the Thompson Square parkland. There are glimpses to the river and the existing bridge through the trees.

Visual impact assessment

The Proposal would not change the sensitivity rating assessed in the EIS, which would remain High. The Proposal widens Bridge Street by approximately 3 metres compared to the original Project, however, no additional trees are proposed to be removed. The increased road width would not be apparent from this viewpoint due to the intervening landform in the park, retaining the existing Moderate magnitude rating. Therefore, the overall visual impact rating would remain High to Moderate.

03

Viewpoint 7

Location

Thompson Square parkland looking north.

Description

The upper central section of Thompson Square parkland is a shady, grassed area with a number of picnic tables and benches scattered around. A white rail-on-edge fence and small embankment separates the park from Old Bridge Street. Glimpses of the river are evident through the trees.

Visual impact assessment

The Proposal would not change the sensitivity rating assessed in the EIS, which would remain High. The Proposal widens Bridge Street by approximately 3 metres compared to the original Project, however, no additional trees are proposed to be removed. The increased road width would be noticeable from this viewpoint as the top of the embankment moves up to 3m closer to the viewpoint, however, the magnitude rating would remain High to Moderate. This would maintain the overall visual impact rating as High.

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Mitigation Measures & Conclusion

Section 04

04 Mitigation Measures

A number of mitigation measures are provided in the EIS to be included in the detailed design phase of the project, aimed at reducing the impact of the original Project on the existing character of Thompson Square. In addition to these, the following mitigation measures are proposed:

- Maintaining the health of the existing Araucaria cunninghamii (Hoop Pine)* by ensuring that:
  - The cut batter does not encroach on the structural root zone of the tree including the potential for the construction of a low (less than 1m high) retaining wall along the new footpath edge to remove the need for the cut batter
  - Trenching for lights and other services does not breach the existing ground surfaces below the tree
  - Ensure the overhanging canopy is protected and retained as its shape is important for its aesthetic appearance.

* Please note that this tree was incorrectly identified in the Urban Design and Landscape Concept Report (including Landscape Character and Visual Impact Assessment) (October 2012) as Araucaria bidwilii. It was subsequently correctly identified as Araucaria cunninghamii in the Aboricultural Development Assessment Report (20th May 2013), prepared by Moore Trees Aboricultural Services.

Additional tree planting along the parkland edge of Bridge Street should be considered if additional visual separation is required between the parkland and the road.

04 Conclusion

In summary, the qualitative assessment concluded that while the Proposal would marginally increase the magnitude of the landscape character impact to LCZ 1, the increase was not sufficient to increase the overall magnitude ratings. Therefore, the overall predicted rating for the impact to the landscape character is unchanged to that identified in Section 7.4 of the EIS.

The proposed changes would marginally increase the magnitude ratings of Viewpoints 5 and 7, however, this would not be sufficient to increase the overall visual impact ratings identified in Section 7.4 of the EIS.

The widening of Bridge Street north, adjacent to Thompson Square by up to 3 metres will reduce the parkland of Thompson Square along the Bridge Street frontage. While the degree of change to the original project will be evident, it will not be enough to change the visual impact from that assessed in the previous report. Additional mitigation measures have been identified to maintain the health of the Araucaria cunninghamii (Hoop Pine) and the potential for additional trees to be planted along the parkland edge to Bridge Street.

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Appendix F – Noise Assessment

Windsor Bridge Replacement

RMS

Noise Impact Assessment

| Rev 0

August 30, 2019

Client Reference

Windsor Bridge Replacement

Project No:	IA098200
Document Title:	Noise Impact Assessment
Document No.:	
Revision:	Rev 0
Date:	August 30, 2019
Client Name:	RMS
Client No:	Client Reference
Project Manager:	Tim Rodham
Author:	Rebecca Warren
File Name:	\\Jacobs.com\ANZ\IE\Projects\04_Eastern\IA098200\Technical\Environmental\Noise Modelling Update Zipper Lane\August 2019\IA98200-NIA-RP-Noise Impact Assessment_Draft A.docx

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Document history and status

Revision	Date	Description	By	Review	Approved
A	13/07/2017	Noise impact assessment of Bridge Street Northbound Merge Lane	Raymond Sim	David Borella	Tim Rodham
Rev 0	05/08/2019	Figures updated and qualitative assessment of recreational receivers	Rebecca Warren	Damien Wagner	

Contents

1. Introduction

Roads and Maritime is proposing two minor design amendments to improve northbound traffic flow as follows:

Amendment 1: Two through lanes at the northbound approach of the Bridge and George Street intersection:

- left lane: shared left turn and through lane
- right lane: dedicated through lane.

This would improve traffic flow and reduce travel times by allowing two lanes of northbound traffic to move through the intersection, rather than one.

Amendment 2: A new merge lane exiting the Bridge and George Streets intersection:

- 100 metres long (including a 30metre parallel lane and 70 metre 'zip' merge lane)
- the lane merges into one northbound lane on the new bridge.

This reduces congestion by allowing motorists to stay in their lanes right up until the merge point.

This high-level assessment details the change in noise level associated with the proposed addition of a 100m long northbound merge lane (30m parallel lane with 70m zip lane) to Bridge Street north of George Street as indicated in Figure 1.1.

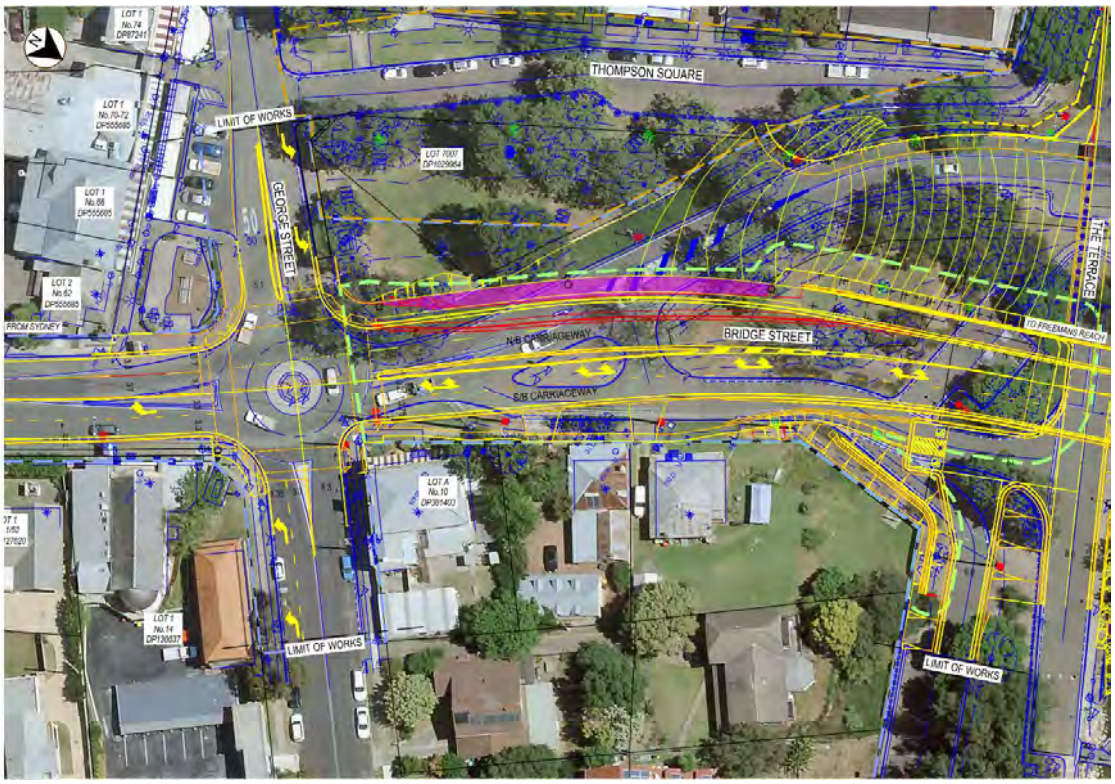

Figure 1.1 : Revised merge lane design

No operational vibration impacts are expected as a result of the revised design, therefore vibration impacts have not been considered in this assessment.

The assessment of the proposal's impact has been based on predicted traffic noise increase to the receiver potentially most affected by the addition of the merge lane – residential receiver "R3" (10 Bridge Street) as indicated in Figure 1.2.

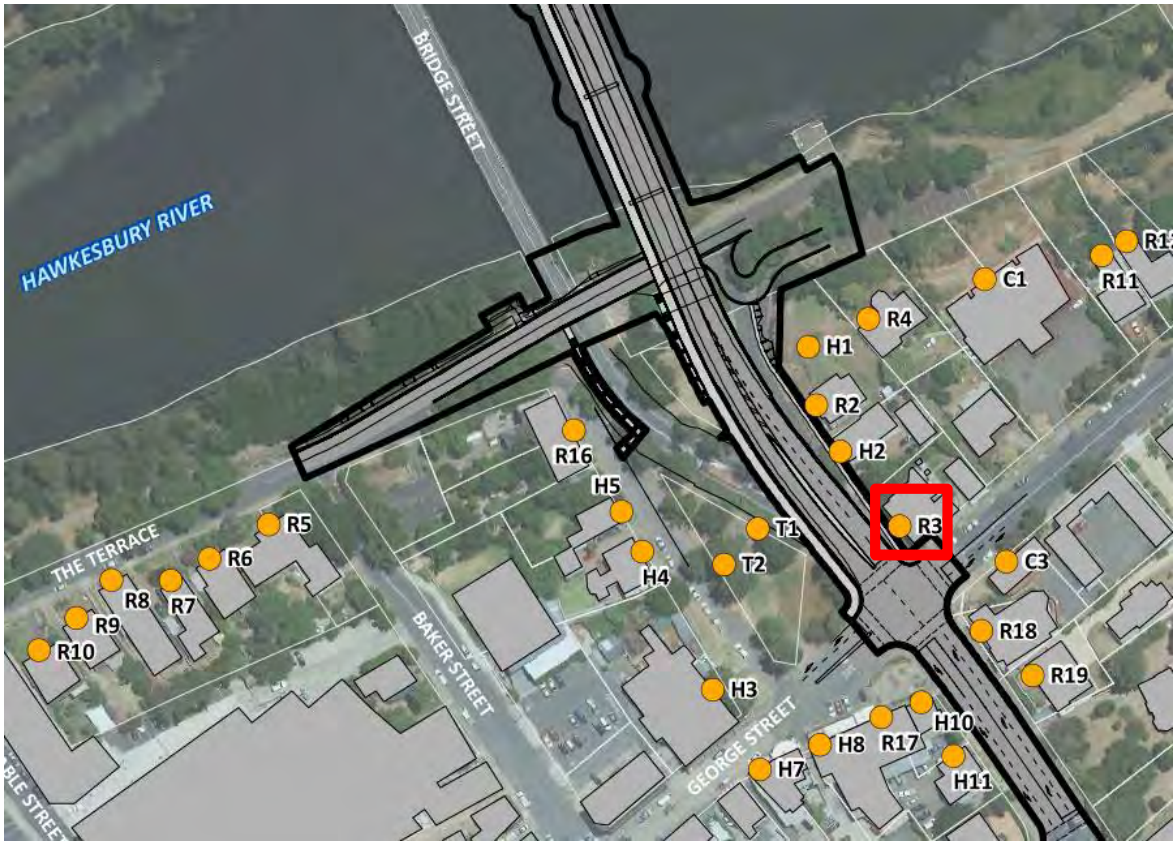

Figure 1.2 : Location of Assessed Receiver, R3 (Residence)

Receivers immediately west of the proposed merge lane are heritage commercial premises ("H" receivers) or passive recreation areas ("T" receivers – Thompson Square), and are less acoustically sensitive types than residential receivers, and not subject to relative increase criteria such as residential criteria. Changes in noise levels within these recreational areas would be minor; levels in the southern portion would increase due to the relocation of traffic lanes westward at the George St intersection, however levels would reduce in the north as the design increases separation distances to the design.

2. Road traffic volumes

This noise assessment of the proposal is based on traffic volumes for the year of opening (2026) as provided in the *Windsor Bridge Replacement Project Traffic and Options Modelling Report*, Revision G (Arcadis, 21 June 2017). The traffic volumes used in the noise assessment are presented in Table 2.1 below.

Table 2.1 : Road traffic volumes for 2026 year of opening used in noise assessment

Lane	Daytime (15 hour)				Night-time (9 hour)			
	Light Vehicle	Heavy Vehicle	Total	% Heavy Vehicle	Light Vehicle	Heavy Vehicle	Total	% Heavy Vehicle
Bridge Street – northbound								
Merge Lane	1672	126	1798	7	148	17	165	10
Right Lane	8978	676	9652	7	796	89	885	10
Bridge Street - southbound								
Left Lane	4867	311	5178	6	965	107	1072	10
Right Lane	4867	311	5178	6	965	107	1072	10

The traffic figures in the above table have been derived from the Arcadis report, which indicates traffic volumes of 12,500 vehicles per day (vpd) northbound and 12,500 vpd southbound in the 2026, the year of project opening. Guidance for the distribution of traffic volumes over the through- and merge-lanes was taken from Figure C-2 of the Arcadis report which indicates that the merge lane would convey approximately 16% of all vehicles.

The posted speed limit for the proposed road – including the merge lane - is 50 km/h.

The prediction of change in noise level was based on the assumption that the revised road design would convey the same volume of traffic as the original design (given as 12,500 vpd in each of the single northbound and southbound lanes).

3. Noise assessment methodology

The prediction of daytime (15 hour) and night time (9 hour) noise level change to Receiver R3 was determined using the UK Department of Transport, *Calculation of Road Traffic Noise* (CoRTN 1988) algorithms. The calculation algorithm allows for traffic volume and mix, type of road surface, vehicle speed, road gradient and ground absorption.

In the absence of confirmed information, the assessment was based on the following assumptions:

- Distances from lane edge to Receiver R3 have been determined from AutoCad drawings provided by the project road engineer.
- Road gradients of Bridge Street have been advised to be “Shallow Downhill” for northbound lanes and “Shallow Uphill” for southbound lanes by AutoCad drawing provided by the project road engineer.
- Angle of view to the road from receiver R3 has been taken to be 70 degrees, which covers the entire length of the merge lane.

4. Noise assessment results

The predicted total traffic noise level to Receiver R3 resulting from the original design (without merge lane) and from the revised design (with merge lane) are presented in Table 4.1 below. The table indicates that no change to the total traffic noise level to Receiver R3 will result due to the addition of the merge lane.

Table 4.1 : Predicted noise impacts at Receiver R3

Lane	Predicted road traffic noise – dB(A)	
	Daytime $L_{Aeq,15hour}$	Night-time $L_{Aeq,9hour}$
Original Bridge Street design (without merge lane)		
Northbound Lane	71.1	61.4
Southbound Left Lane	73.1	67.2
Southbound Right Lane	71.4	65.5
Total noise level	**76.7**	**70.1**
Revised Bridge Street design (with merge lane)		
Northbound Merge Lane	62.7	52.4
Northbound Right Lane	70.3	60.7
Southbound Left Lane	73.1	67.2
Southbound Right Lane	71.4	65.5
Total noise level	**76.7**	**70.1**

The CoRTN spreadsheet calculations are presented in Appendix A of this memo.

5. Conclusion

This memorandum details the assessment of the potential for change in noise levels associated with the proposed addition of a northbound merge lane to Bridge Street, north of George Street.

The assessment concludes that no change in noise (0 dBA) to nearby sensitive receivers will result due to the addition of the merge lane.

Appendix A. CoRTN Spreadsheet Calculations

Original road design of Bridge Street northbound lane:

CoRTN Traffic Noise Calculation

Parameters:		
Total AADT (single direction)		12501
Daytime traffic (%)		92%
HV Daytime (%)		7%
HV Night time (%)		10%
Angle of view (default 140°)		70
Road : Receiver Seperation Distance (m)		18.35
Average Speed (km/hr)		50
Road Surface	DGR	
Ground Surface	Soft	
CONCAWE Meteorological Category	4 - Neutral	
Gradient (single direction)	Shallow Downhill	

Input traffic numbers:		
Daytime	Heavy	802
(15 hour)	Light	10649
Night time	Heavy	105
(9 hour)	Light	945

Barrier Input Parameters (if applicable)	Ground Plane	Ht above Ground
Height of Receiver (RL)		
Height of Source (RL)		
Height of Barrier (RL)		
Source-Barrier Distance		
Receiver-Barrier Distance		

Traffic noise prediction:		
Daytime Noise Level	**71.1**	$L_{Aeq\ 15hr}$
Night time Noise Level	**61.4**	$L_{Aeq\ 9hr}$

Note: includes +2.5dB(A) for facade noise level

Revised road design of Bridge Street northbound right lane:

CoRTN Traffic Noise Calculation

Parameters:		
Total AADT (single direction)		10539
Daytime traffic (%)		92%
HV Daytime (%)		7%
HV Night time (%)		10%
Angle of view (default 140°)		70
Road : Receiver Seperation Distance (m)		18.35
Average Speed (km/hr)		50
Road Surface	DGR	
Ground Surface	Soft	
CONCAWE Meteorological Category	4 - Neutral	
Gradient (single direction)	Shallow Downhill	

Input traffic numbers:		
Daytime	Heavy	676
(15 hour)	Light	8977
Night time	Heavy	89
(9 hour)	Light	797

Barrier Input Parameters (if applicable)	Ground Plane	Ht above Ground
Height of Receiver (RL)		
Height of Source (RL)		
Height of Barrier (RL)		
Source-Barrier Distance		
Receiver-Barrier Distance		

Traffic noise prediction:		
Daytime Noise Level	**70.3**	$L_{Aeq\ 15hr}$
Night time Noise Level	**60.7**	$L_{Aeq\ 9hr}$

Note: includes +2.5dB(A) for facade noise level

Revised road design of Bridge Street merge lane:

CoRTN Traffic Noise Calculation

Parameters:		
Total AADT (single direction)		1962
Daytime traffic (%)		92%
HV Daytime (%)		7%
HV Night time (%)		10%
Angle of view (default 140°)		70
Road : Receiver Seperation Distance (m)		21.85
Average Speed (km/hr)		50
Road Surface	DGR	
Ground Surface	Soft	
CONCAWE Meteorological Category	4 - Neutral	
Gradient (single direction)	Shallow Downhill	

Input traffic numbers:		
Daytime (15 hour)	Heavy	126
	Light	1672
Night time (9 hour)	Heavy	16
	Light	148

Barrier Input Parameters (if applicable)	Ground Plane	Ht above Ground
Height of Receiver (RL)		
Height of Source (RL)		
Height of Barrier (RL)		
Source-Barrier Distance		
Receiver-Barrier Distance		

Traffic noise prediction:		
Daytime Noise Level	62.7	$L_{Aeq\ 15hr}$
Night time Noise Level	52.4	$L_{Aeq\ 9hr}$

Note: includes +2.5dB(A) for facade noise level

Bridge Street southbound left lane:

CoRTN Traffic Noise Calculation

Parameters:		
Total AADT (single direction)		6250
Daytime traffic (%)		83%
HV Daytime (%)		6%
HV Night time (%)		10%
Angle of view (default 140°)		70
Road : Receiver Seperation Distance (m)		10.75
Average Speed (km/hr)		50
Road Surface	DGR	
Ground Surface	Soft	
CONCAWE Meteorological Category	4 - Neutral	
Gradient (single direction)	Shallow Uphill	

Input traffic numbers:		
Daytime (15 hour)	Heavy	311
	Light	4867
Night time (9 hour)	Heavy	107
	Light	965

Barrier Input Parameters (if applicable)	Ground Plane	Ht above Ground
Height of Receiver (RL)		
Height of Source (RL)		
Height of Barrier (RL)		
Source-Barrier Distance		
Receiver-Barrier Distance		

Traffic noise prediction:		
Daytime Noise Level	73.1	$L_{Aeq\ 15hr}$
Night time Noise Level	67.2	$L_{Aeq\ 9hr}$

Note: includes +2.5dB(A) for facade noise level

Bridge Street southbound right lane:

CoRTN Traffic Noise Calculation

Parameters:	
Total AADT (single direction)	6250
Daytime traffic (%)	83%
HV Daytime (%)	6%
HV Night time (%)	10%
Angle of view (default 140°)	70
Road : Receiver Seperation Distance (m)	14.25
Average Speed (km/hr)	50
Road Surface	DGR
Ground Surface	Soft
CONCAWE Meteorological Category	4 - Neutral
Gradient (single direction)	Shallow Uphill

Input traffic numbers:		
Daytime (15 hour)	Heavy	311
	Light	4867
Night time (9 hour)	Heavy	107
	Light	965

Barrier Input Parameters (if applicable)	Ground Plane	Ht above Ground
Height of Receiver (RL)		
Height of Source (RL)		
Height of Barrier (RL)		
Source-Barrier Distance		
Receiver-Barrier Distance		

Traffic noise prediction:		
Daytime Noise Level	71.4	$L_{Aeq\ 15hr}$
Night time Noise Level	65.5	$L_{Aeq\ 9hr}$

Note: includes +2.5dB(A) for facade noise level

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